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Chen et al.

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(45) **Date of Patent: Dec. 31, 2019**

(54) **CAMERA DEVICE WITH ADJUSTABLE APERTURE**

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(73) Assignees: **SINTAI OPTICAL (SHENZHEN) CO., LTD.**, Shenzhen, Guangdong Province (CN); **ASIA OPTICAL CO., INC.**, Taichung (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/396,198**

(22) Filed: **Dec. 30, 2016**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 30, 2015 (CN) 2015 1 1020384
Dec. 30, 2015 (CN) 2015 1 1027143

(51) **Int. Cl.**
H04N 5/225 (2006.01)
G02B 27/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04N 5/2252*** (2013.01); ***G02B 5/005*** (2013.01); ***G02B 9/60*** (2013.01); ***G02B 13/0045*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC G02B 5/005; G02B 27/0006; G02B 9/60; G02B 13/0045; H04N 5/2252; H04N 5/2254
(Continued)

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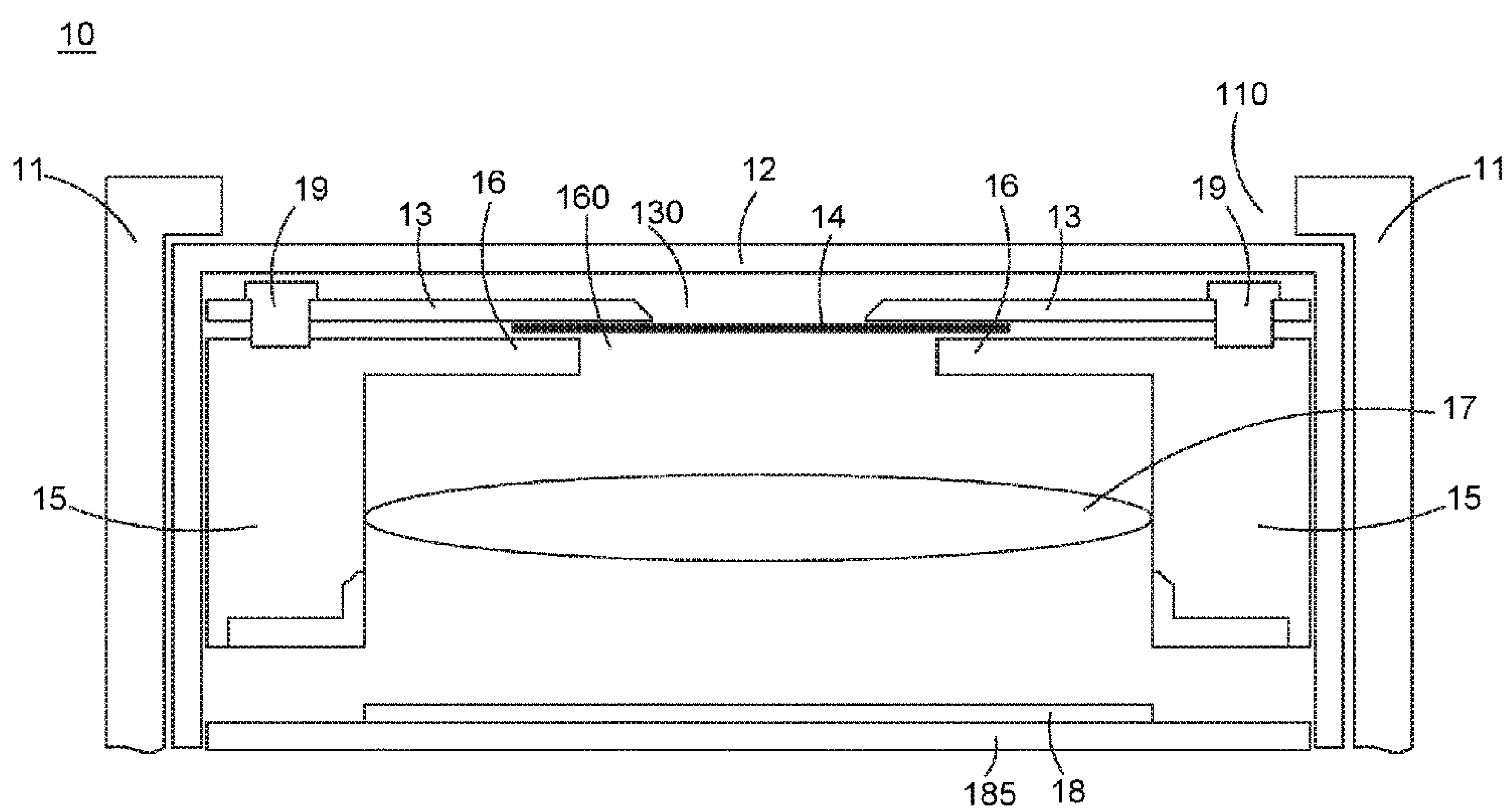
Primary Examiner — Clayton E. LaBalle
Assistant Examiner — Linda B Smith
(74) *Attorney, Agent, or Firm* — Muncy, Geissler, Olds & Lowe, P.C.

(57) **ABSTRACT**

A camera device is packaged inside an external shell of an electronic apparatus. The external shell has an opening. The camera device has a transparent plate, a part of which is adjacent to the opening of the external shell. The transparent plate forms an accommodating space for accommodating other components of the camera device. Thus, the dust can be prevented from falling into a shutter blade room of the camera device. The camera device also includes a shutter blade, a driver, and a plate. The plate has an aperture, and the aperture of the camera device is defined thereby. The aperture of the plate is completely pervious to light when the shutter blade is at a first position, and the aperture of the plate is partially pervious to light when the shutter blade is at a second position, thereby changing the aperture of the camera device.

28 Claims, 36 Drawing Sheets



(51) **Int. Cl.**
G02B 13/00 (2006.01)
G02B 9/60 (2006.01)
G02B 5/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G02B 27/0006*** (2013.01); ***H04N 5/2254*** (2013.01)

(58) **Field of Classification Search**
USPC 396/452
See application file for complete search history.

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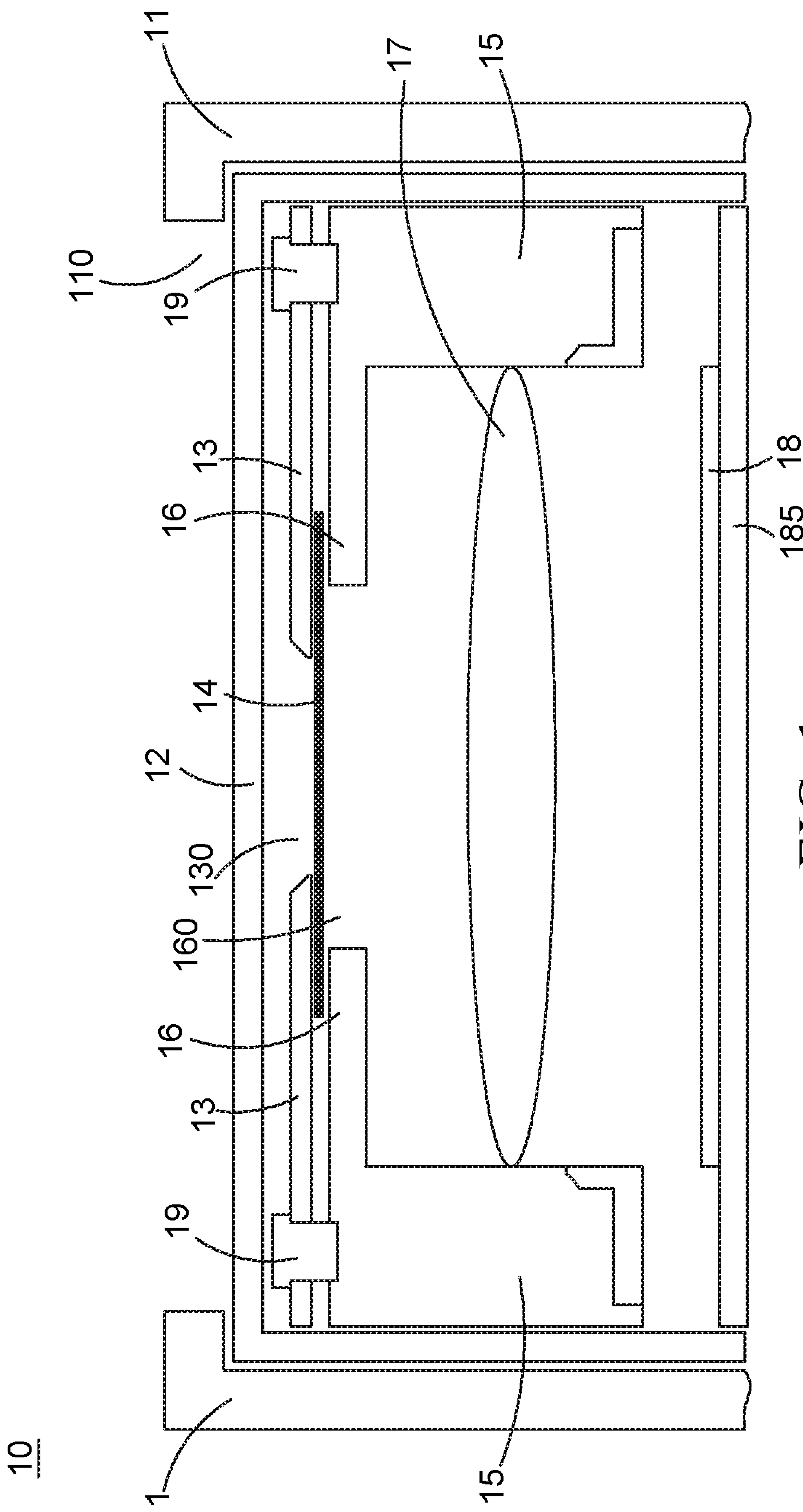


FIG. 1

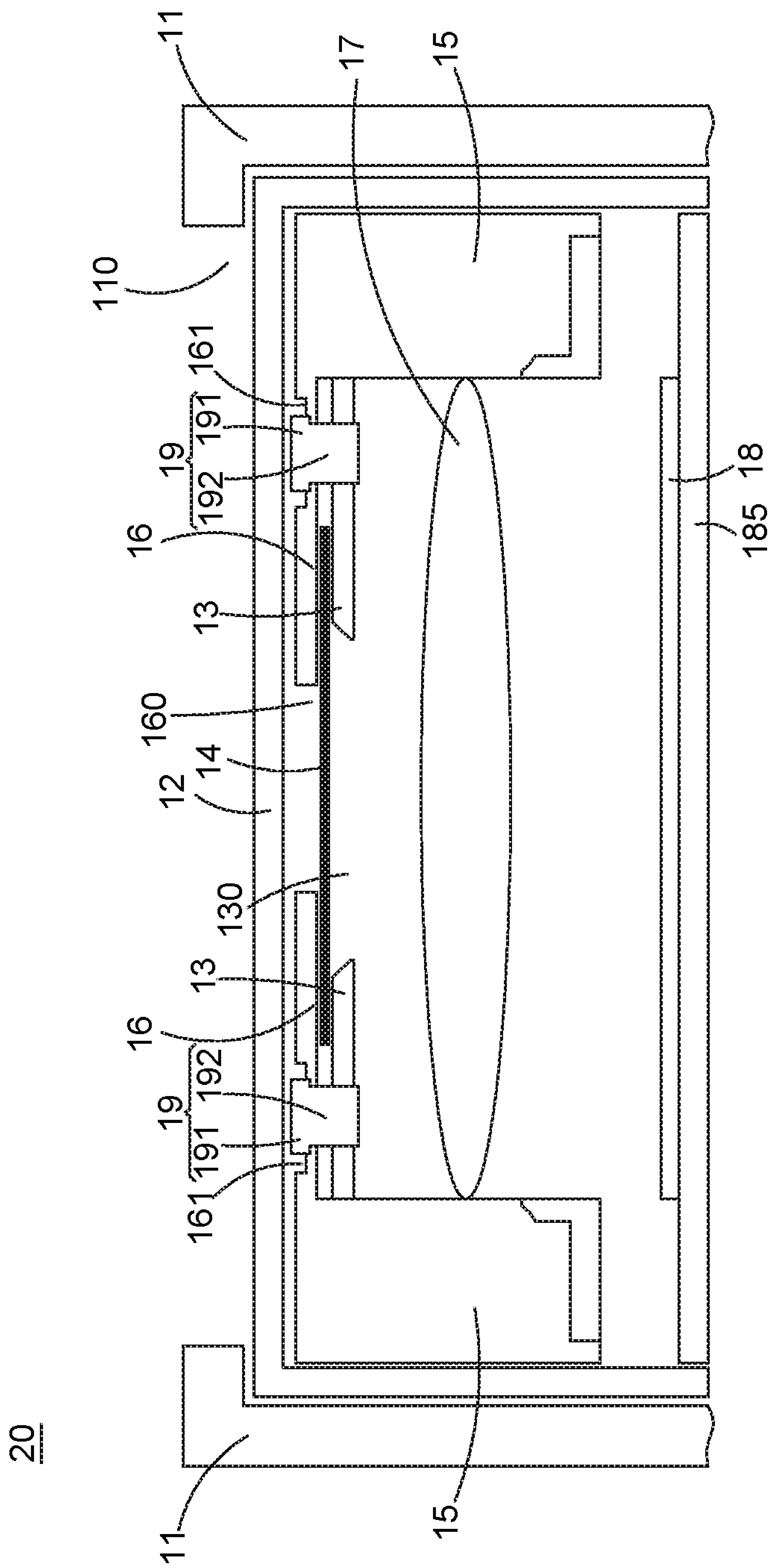
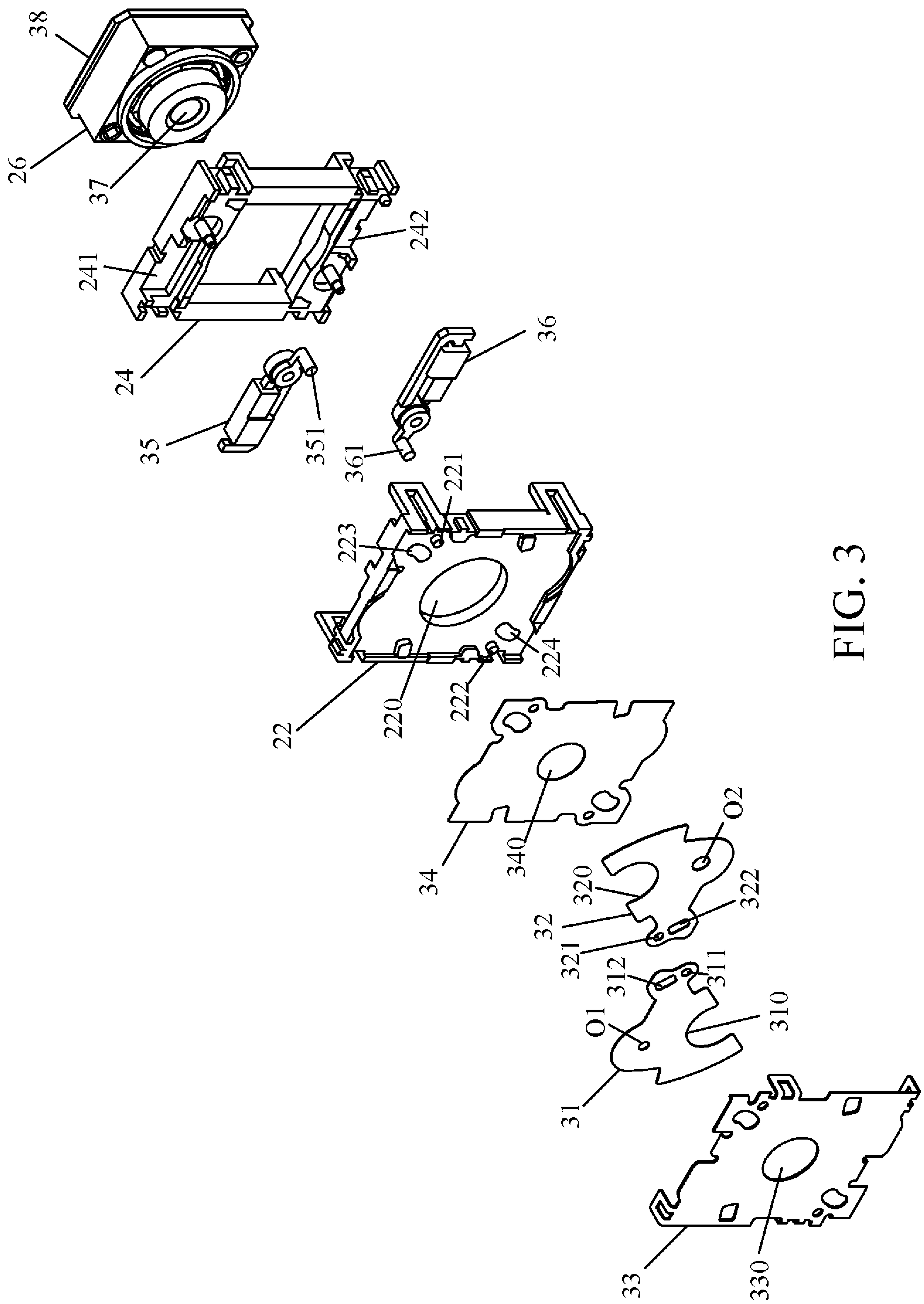


FIG. 2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O2
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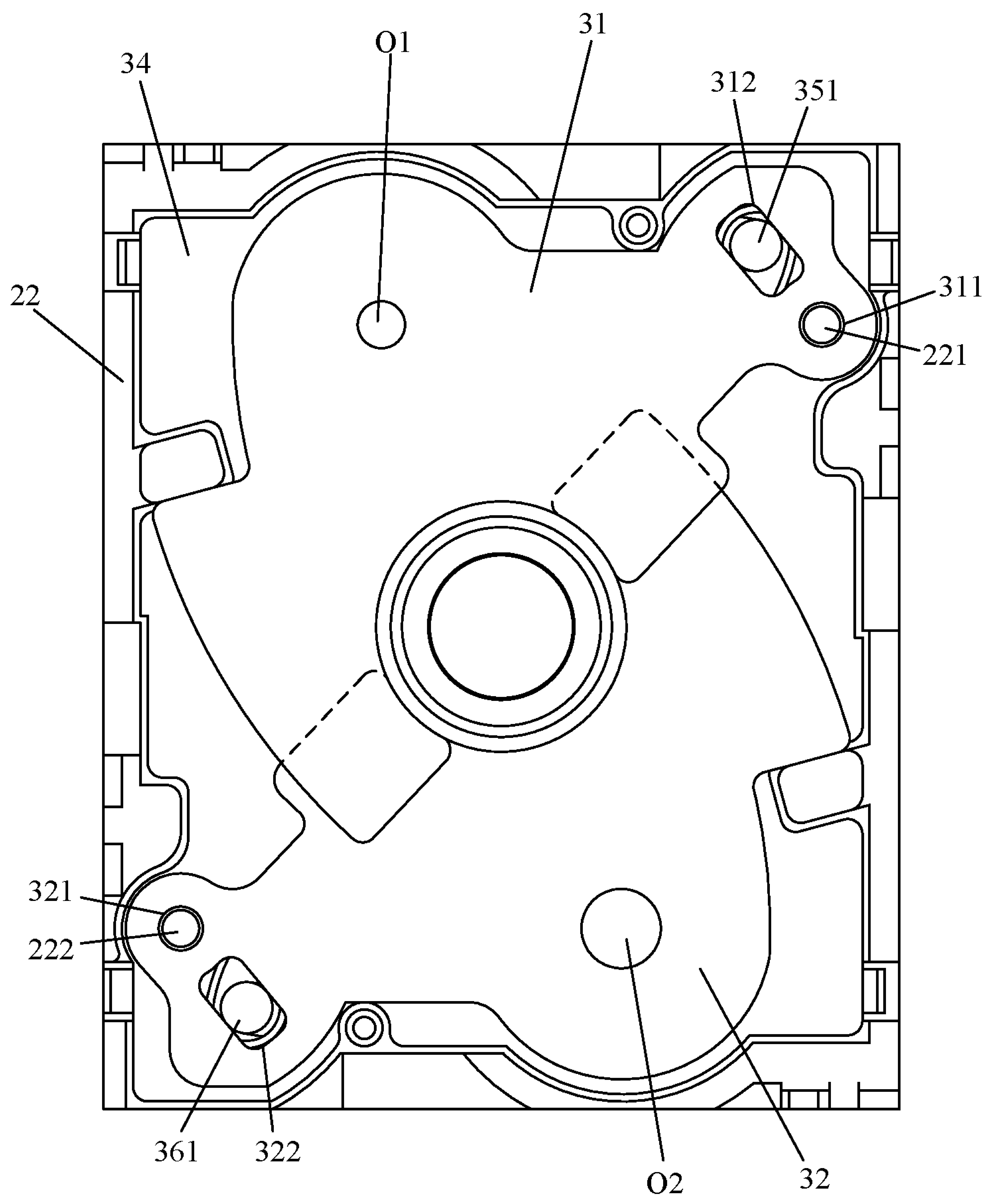
321
312
311
310
O1
31
33
330

FIG. 3



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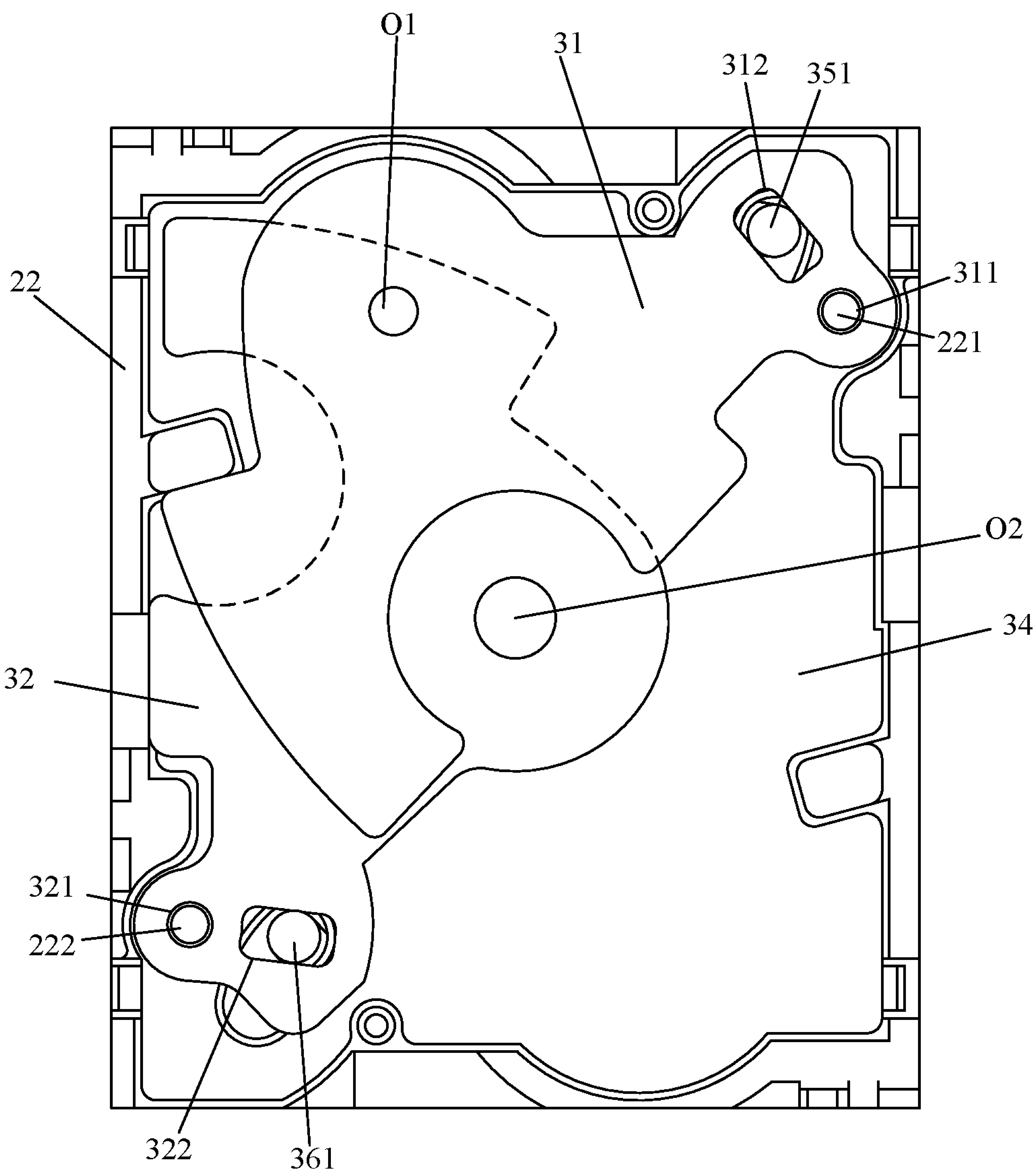


FIG. 5

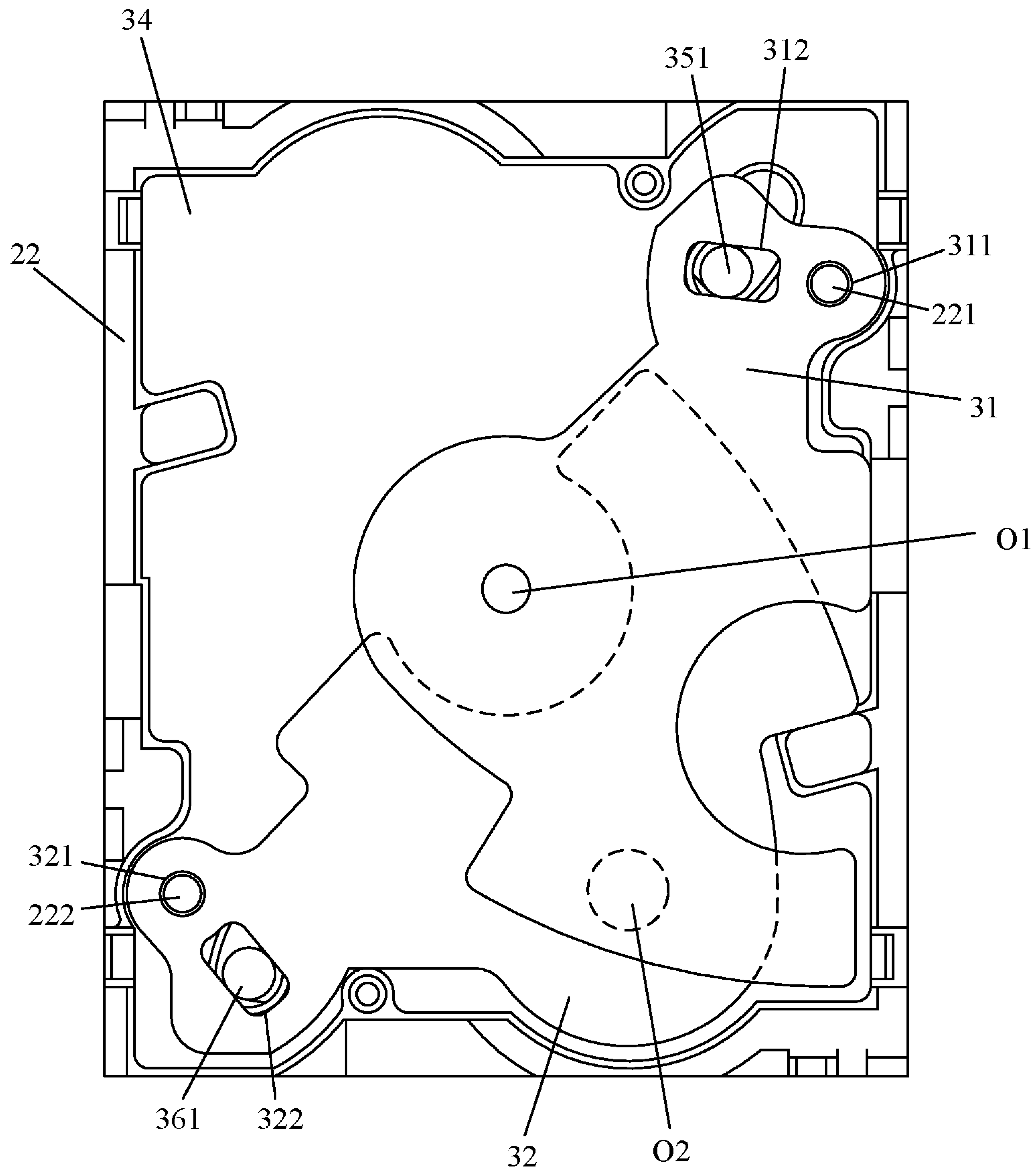


FIG. 6

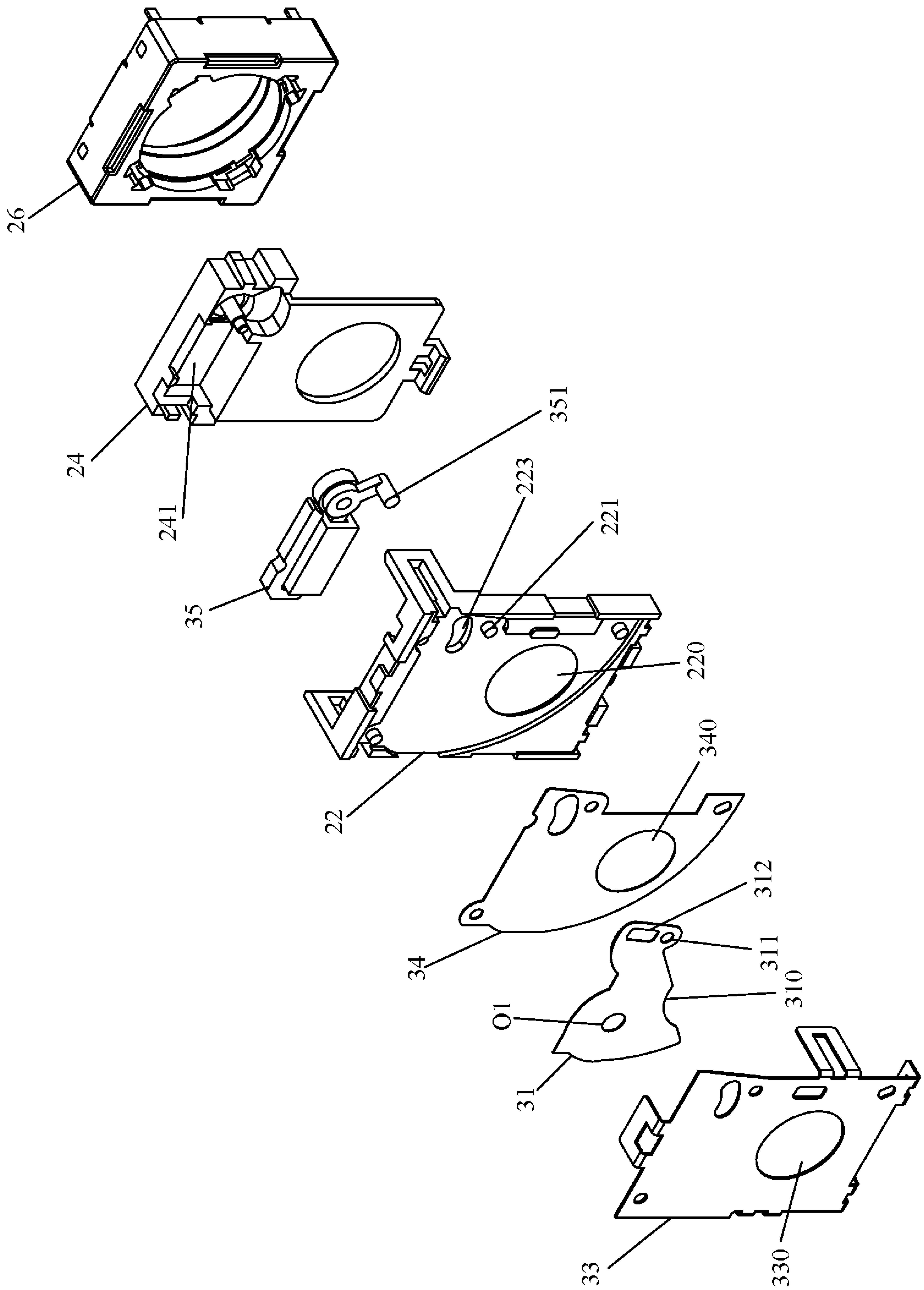


FIG. 7

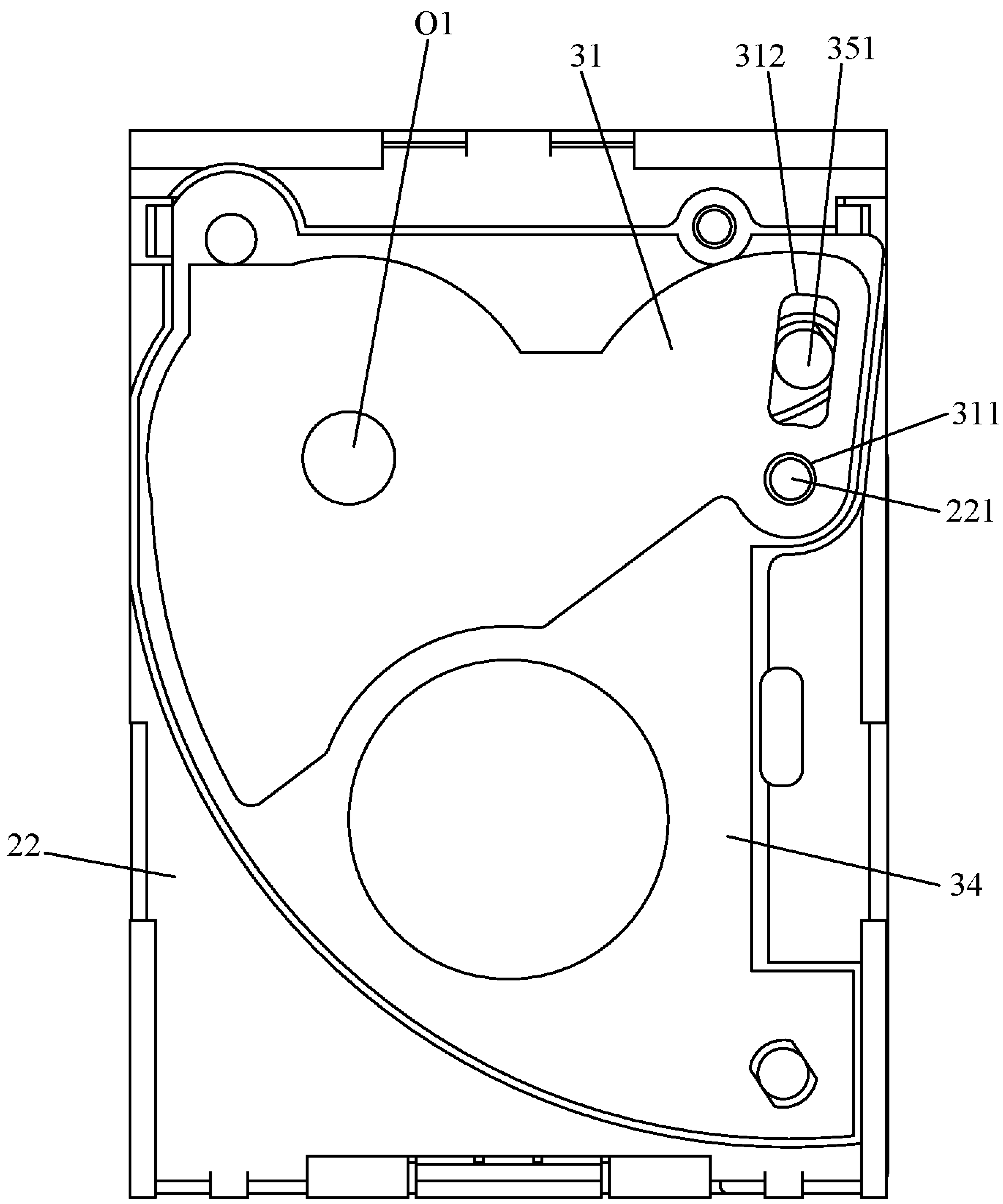


FIG. 8

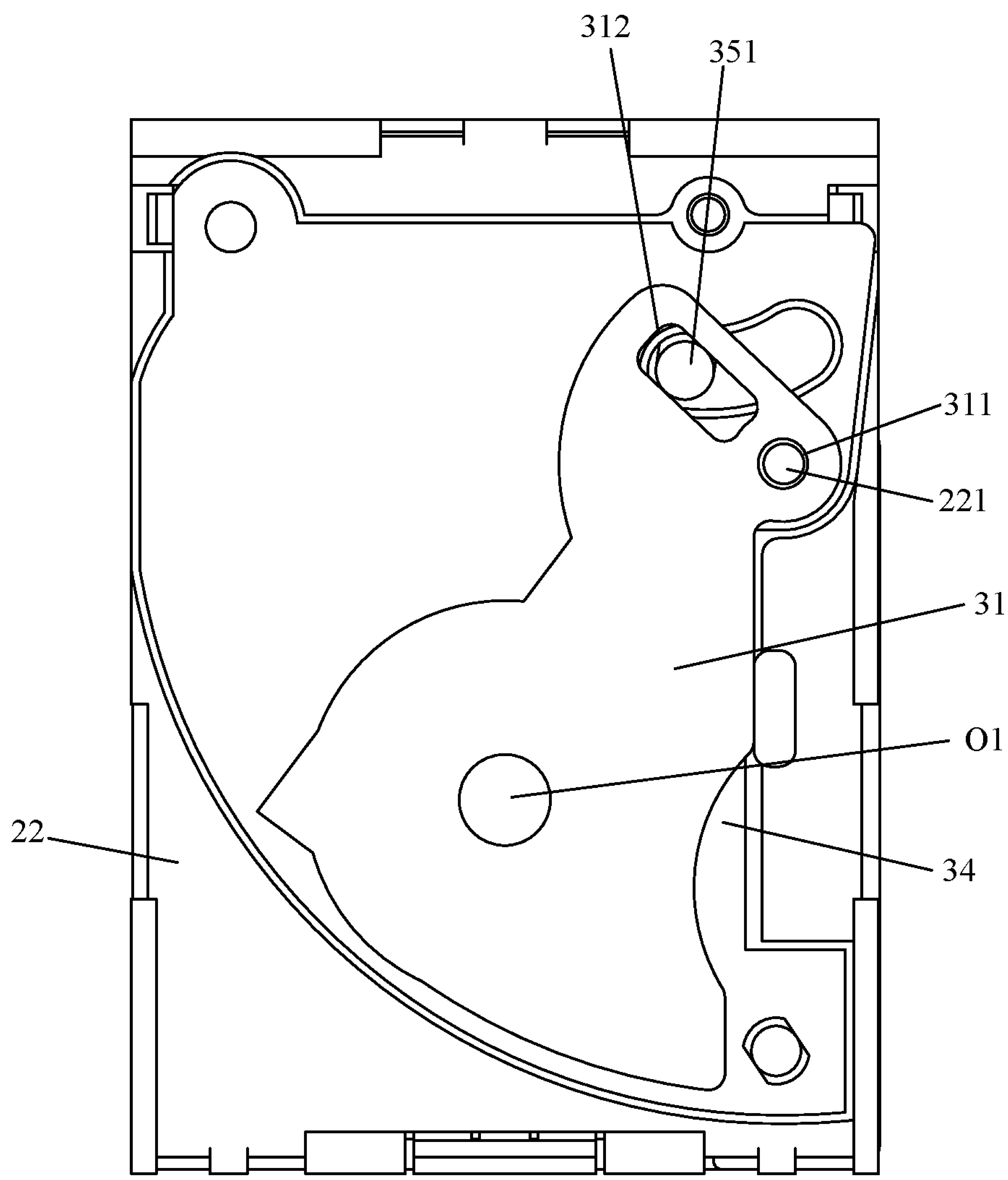


FIG. 9

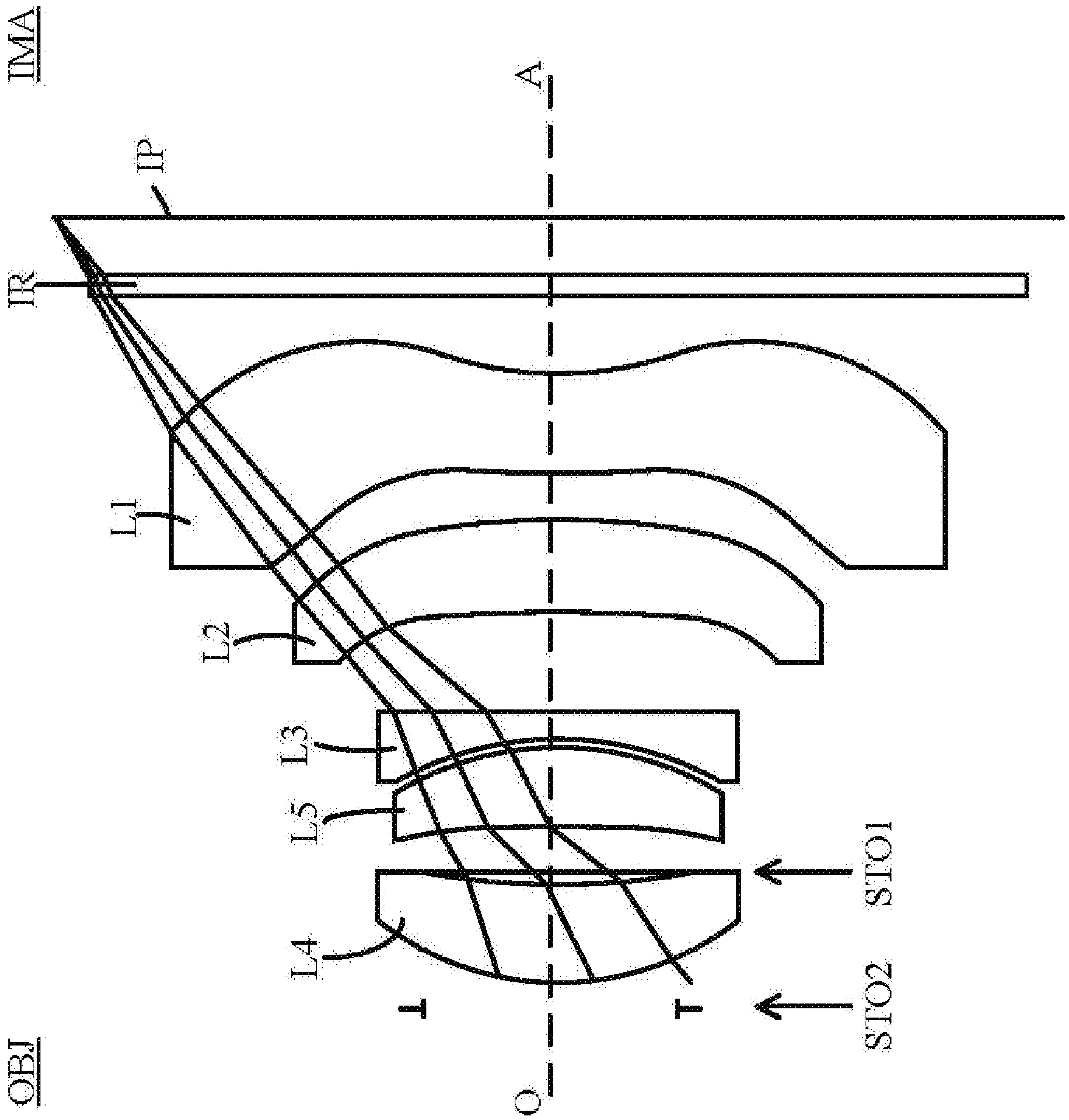


FIG. 10A

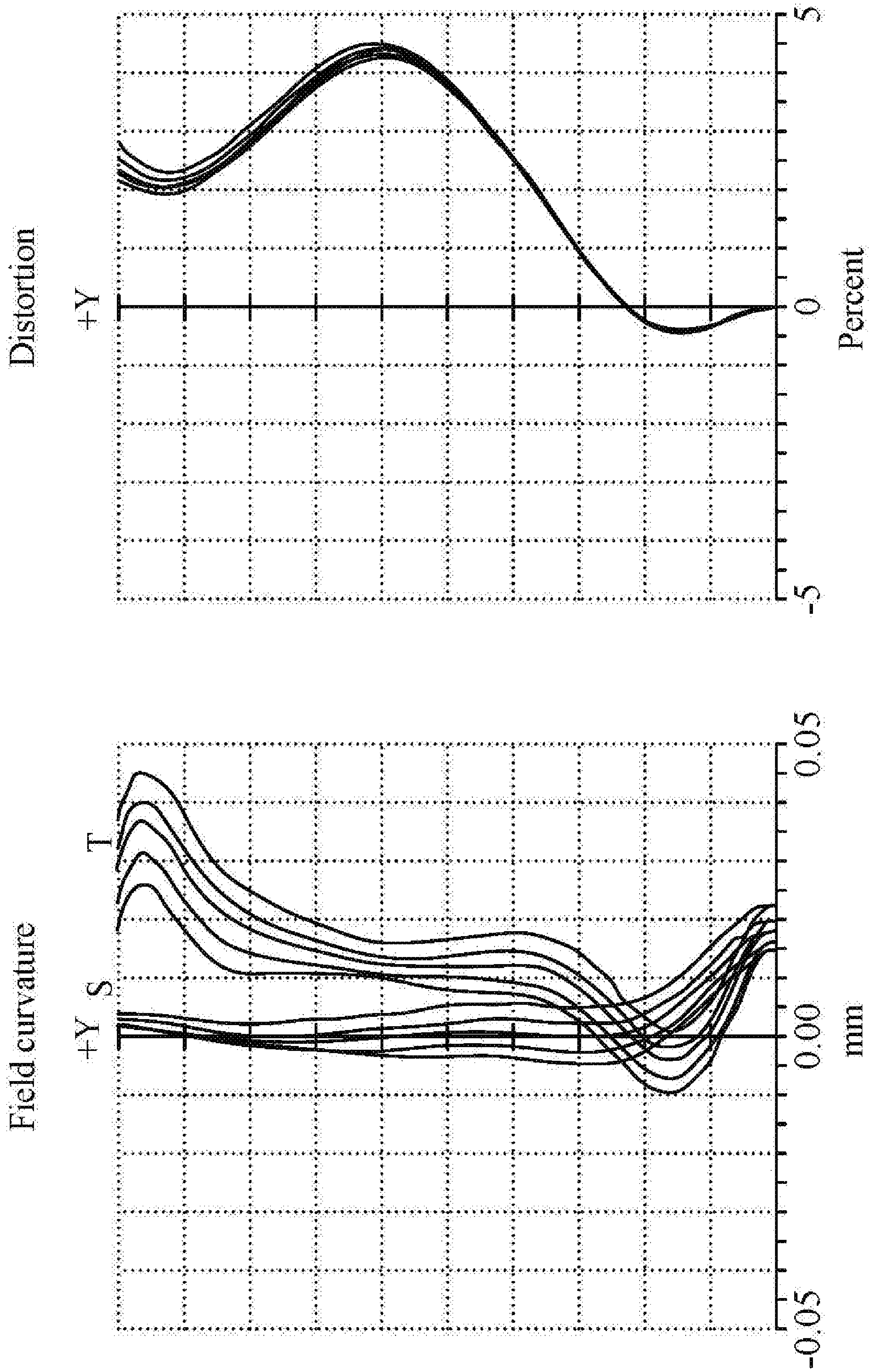


FIG. 10B

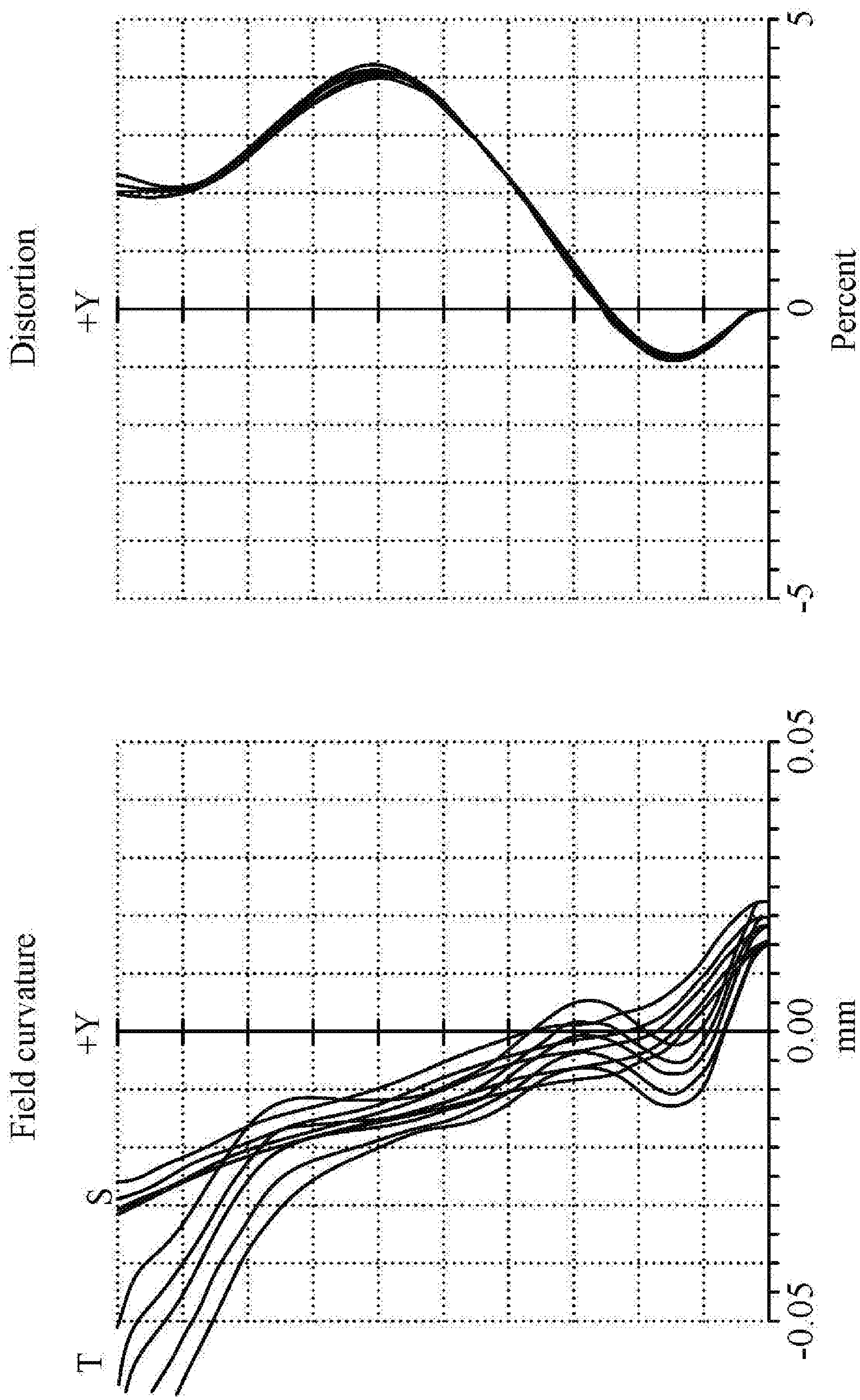
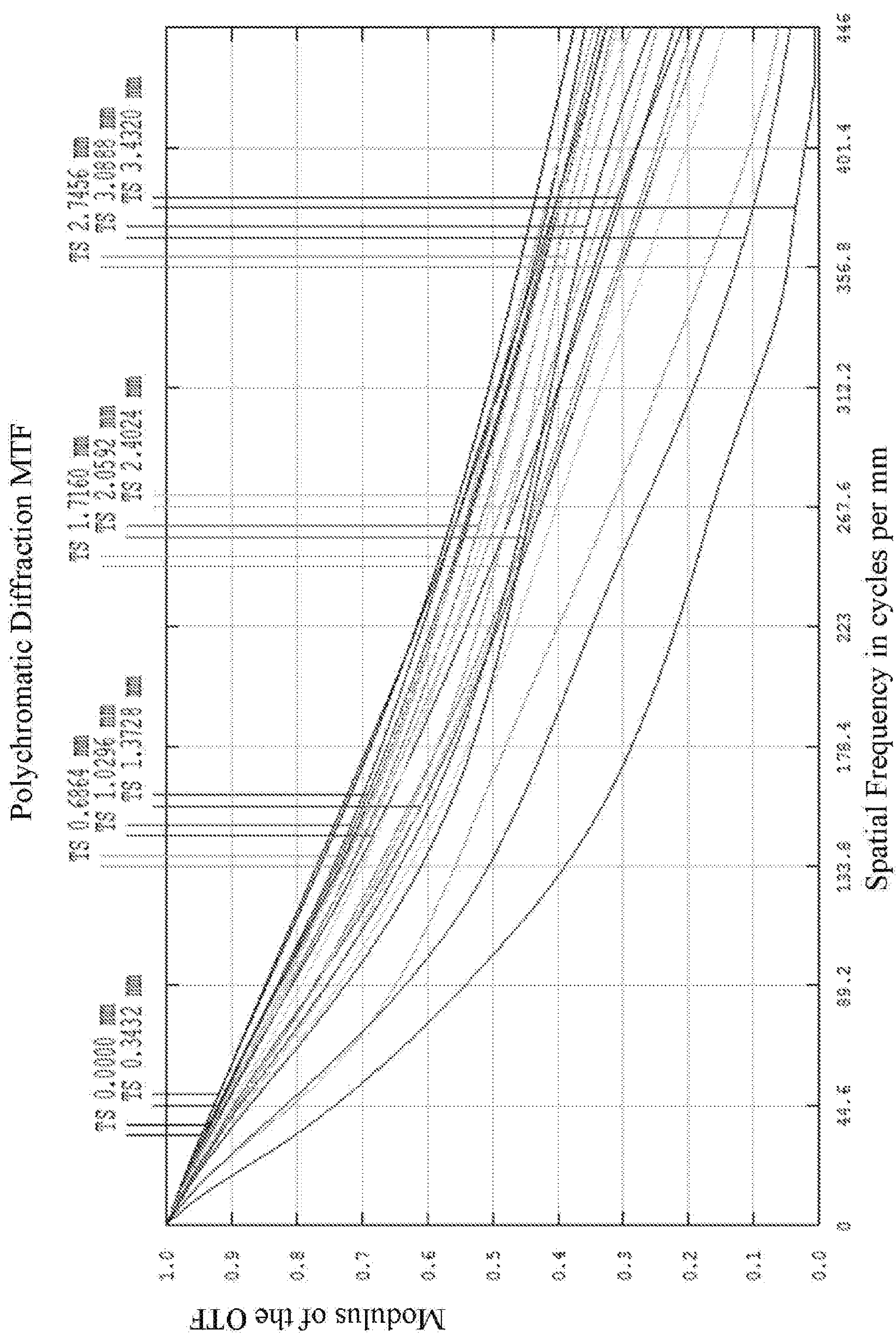


FIG. 10C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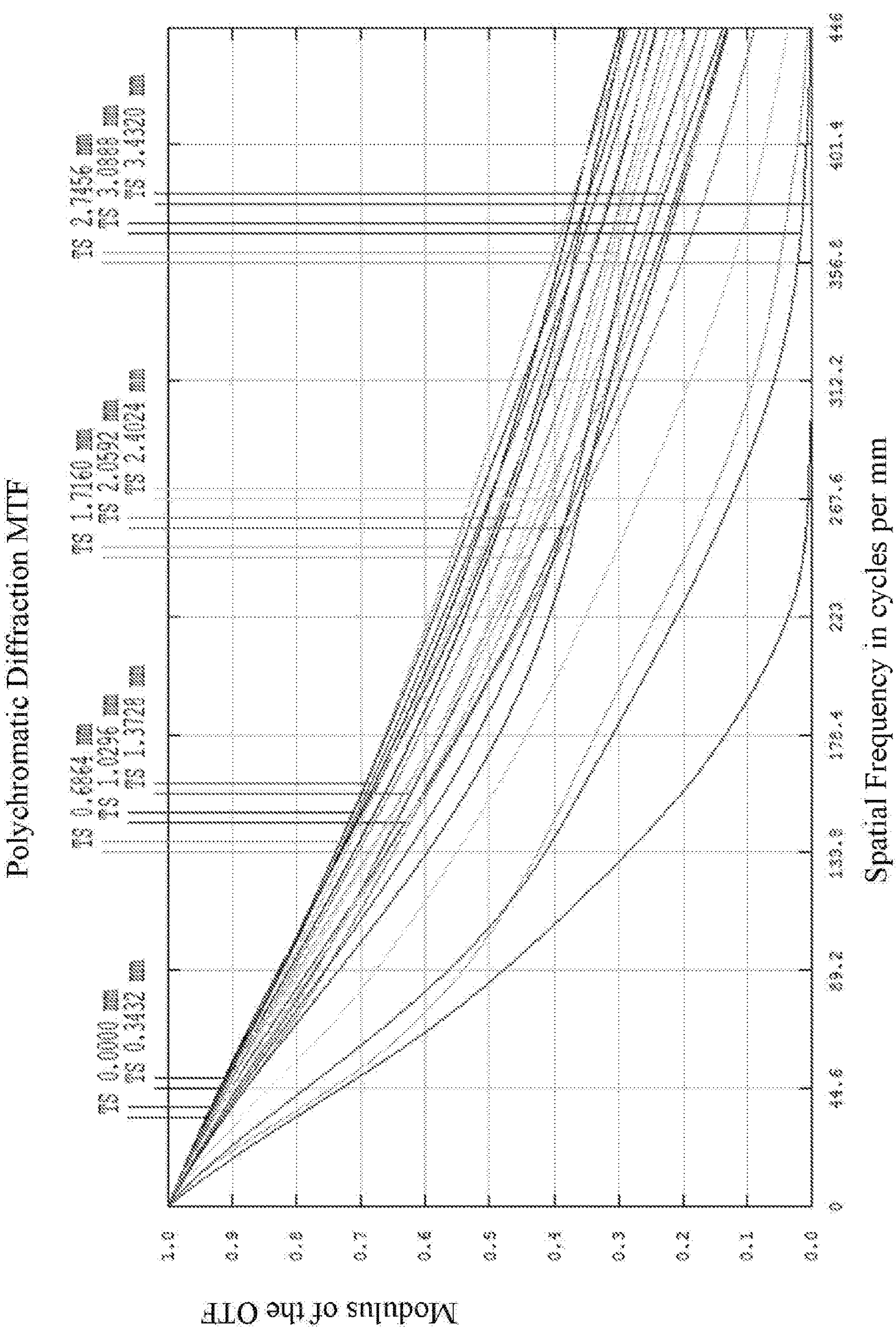
TS 0.3432 mm
TS 0.6864 mm
TS 1.0296 mm
TS 1.3728 mm
TS 1.7160 mm
TS 2.0592 mm
TS 2.4024 mm
TS 2.7456 mm
TS 3.0888 mm
TS 3.4320 mm
Modulus of the OTF
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
44.6
89.2
133.8
178.4
223
267.6
312.2
356.8
401.4
446
Spatial Frequency in cycles per mm

FIG. 10D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TS 1.0296 mm
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TS 2.4024 mm
TS 2.7456 mm
TS 3.0888 mm
TS 3.4320 mm
Modulus of the OTF
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
44.6
89.2
133.8
178.4
223
267.6
312.2
356.8
401.4
446
Spatial Frequency in cycles per mm

FIG. 10E

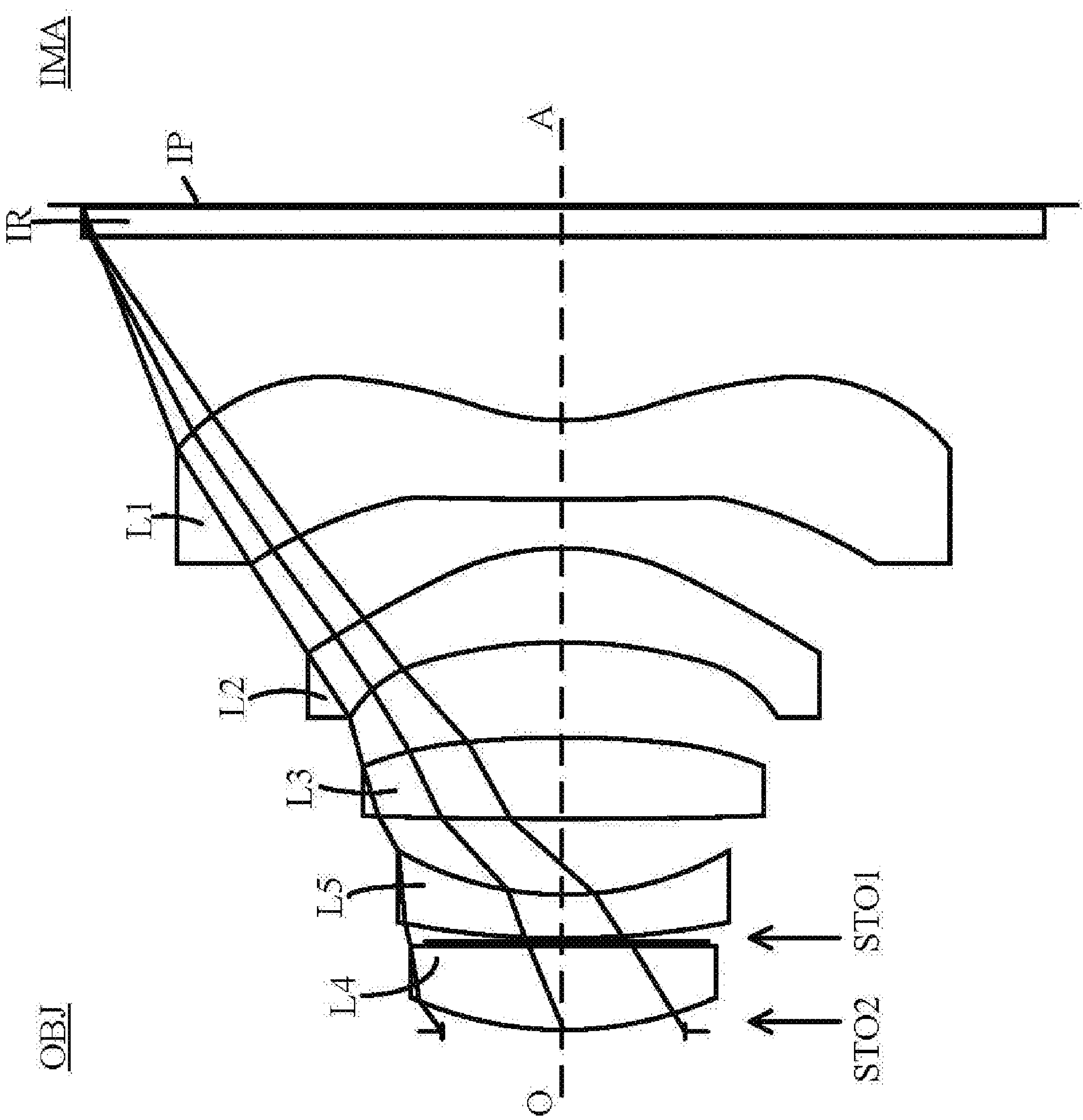


FIG. 11A

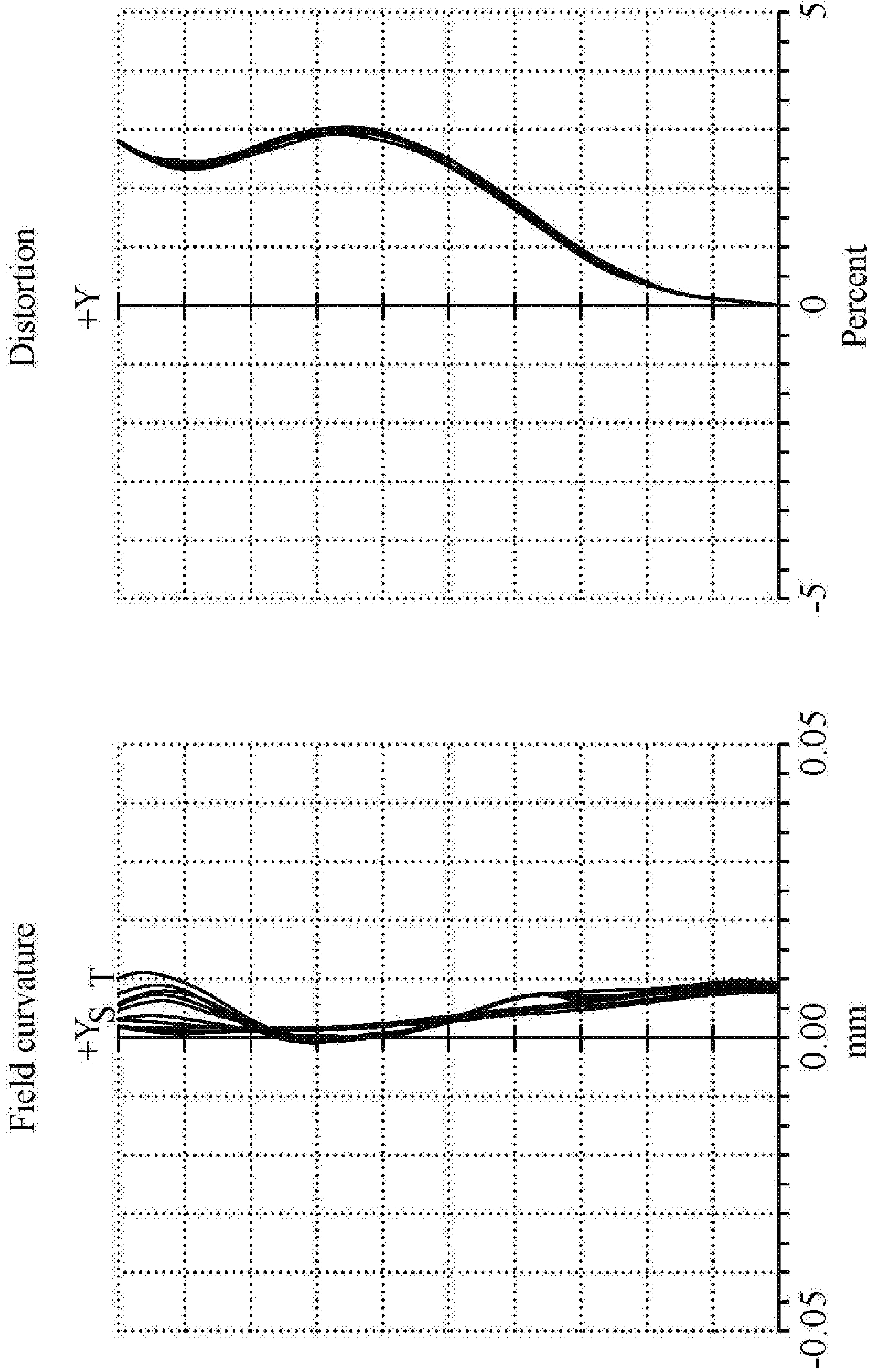


FIG. 11B

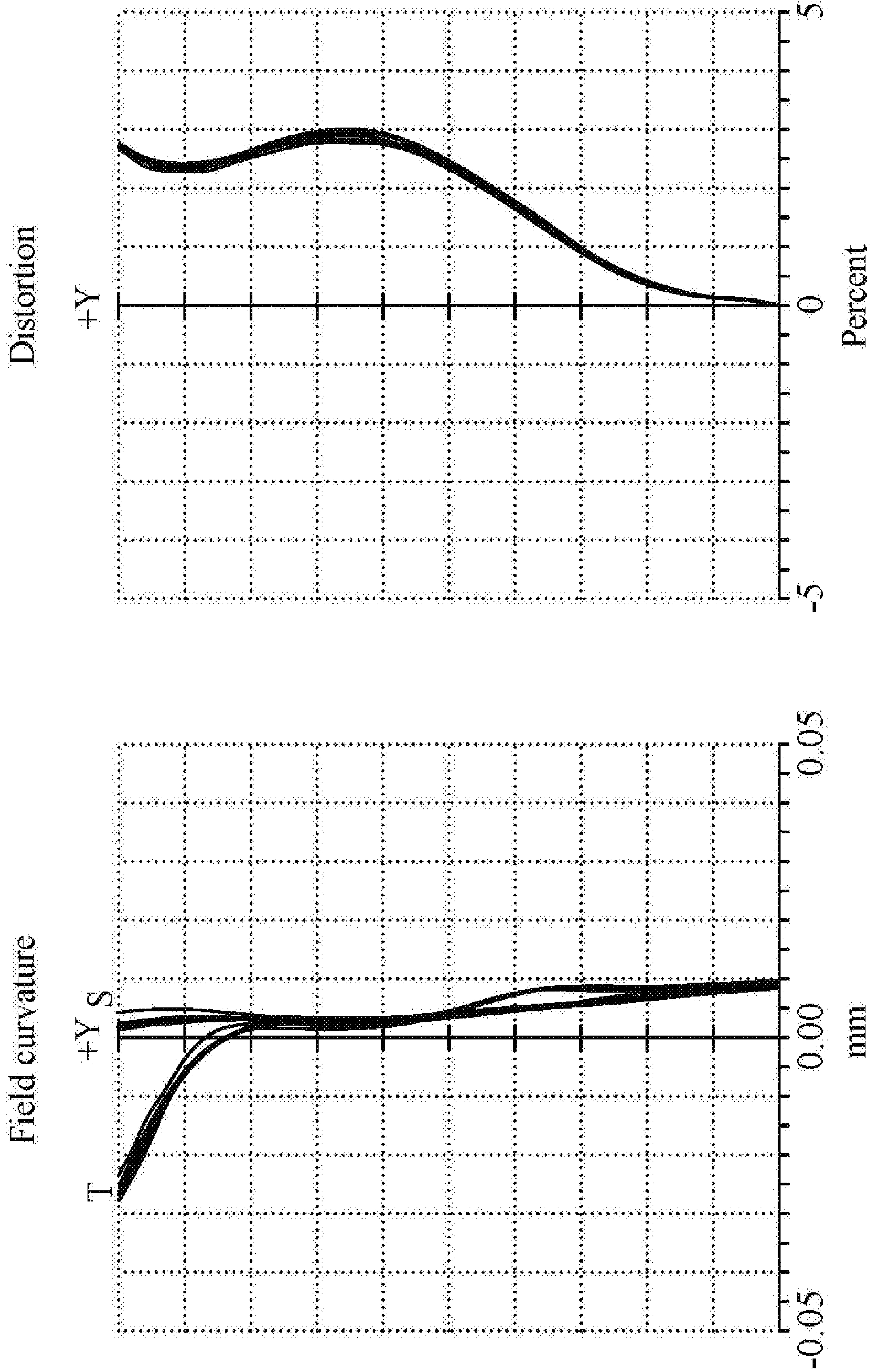
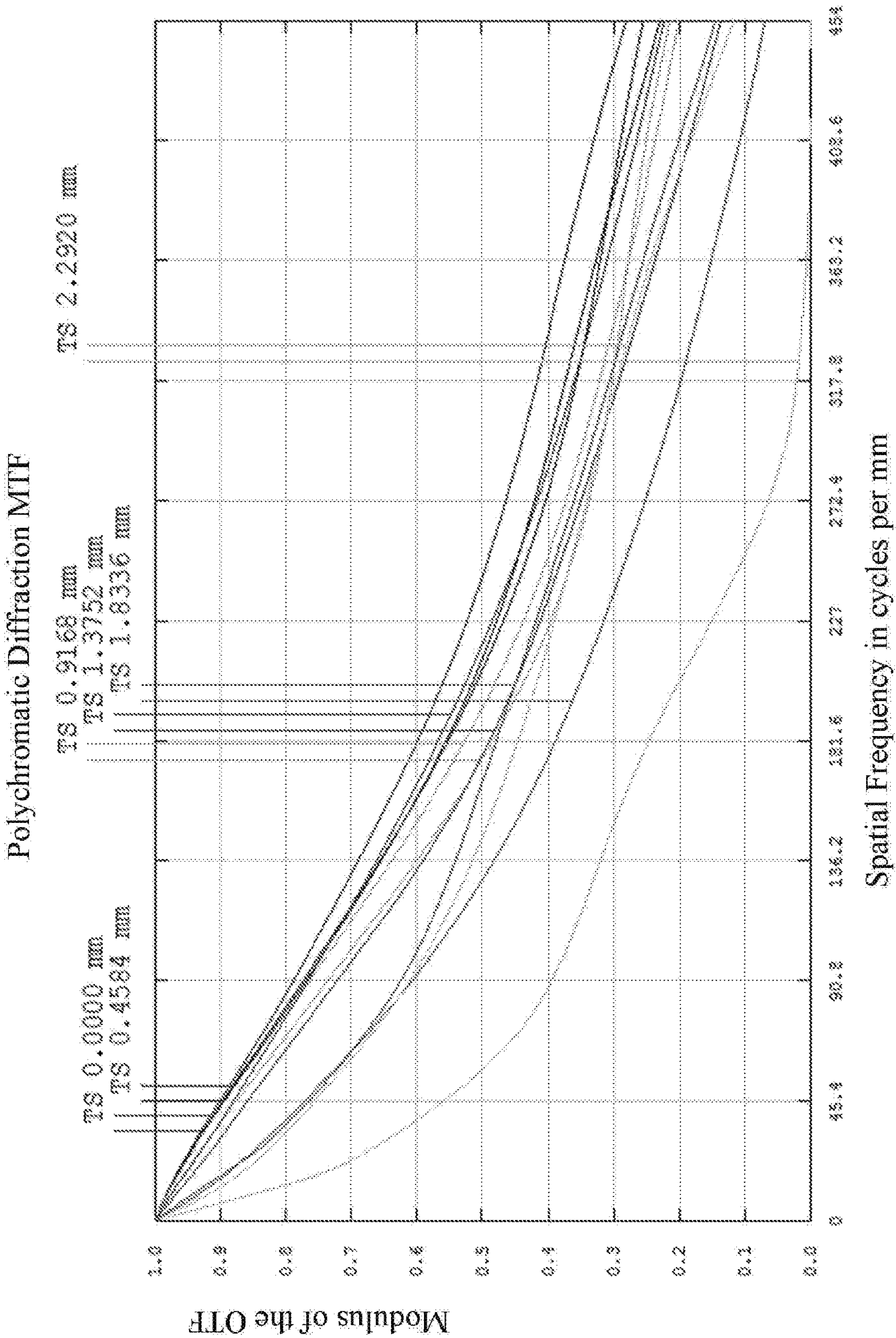


FIG. 11C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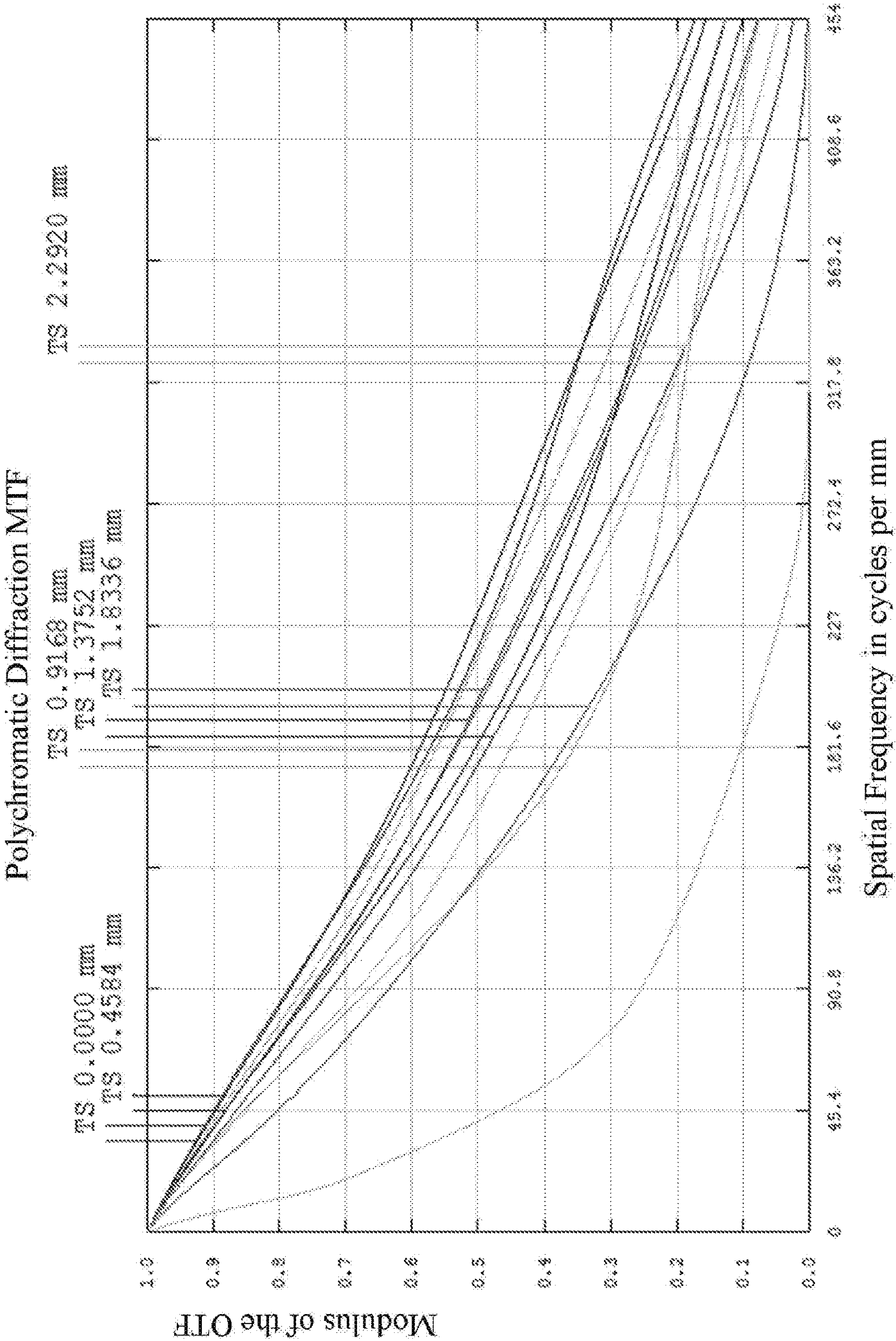
TS 0.0000 mm
TS 0.4584 mm
TS 0.9168 mm
TS 1.3752 mm
TS 1.8336 mm
TS 2.2920 mm
Modulus of the OTF
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
45.4
90.8
136.2
181.6
227
272.4
317.8
363.2
408.6
454
Spatial Frequency in cycles per mm

FIG. 11D



Polychromatic Diffraction MTF
TS 0.0000 mm
TS 0.4584 mm
TS 0.9168 mm
TS 1.3752 mm
TS 1.8336 mm
TS 2.2920 mm
Modulus of the OTF
Spatial Frequency in cycles per mm
0
45.4
90.8
136.2
181.6
227
272.4
317.8
363.2
408.6
454
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

FIG. 11E

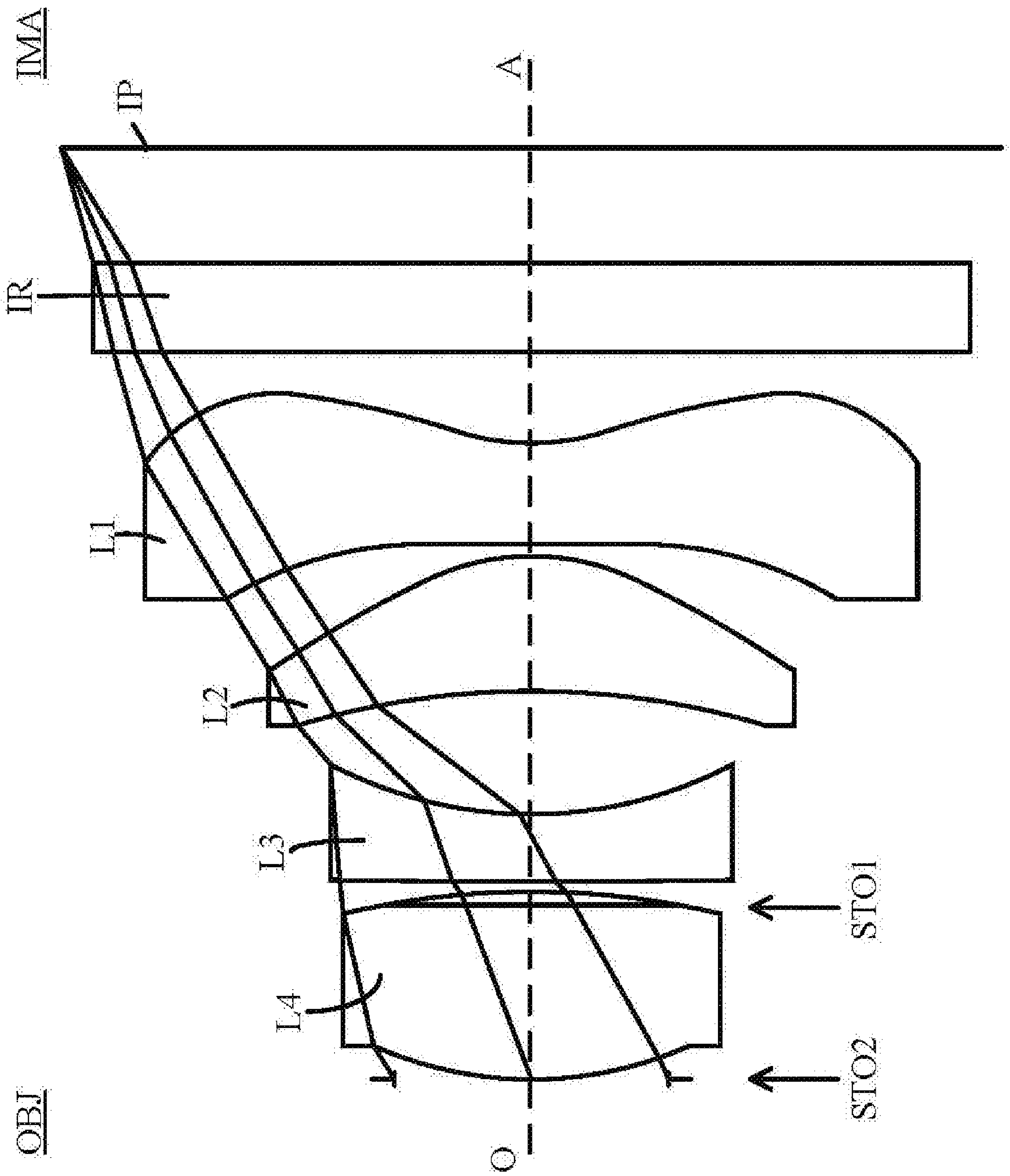


FIG. 12A

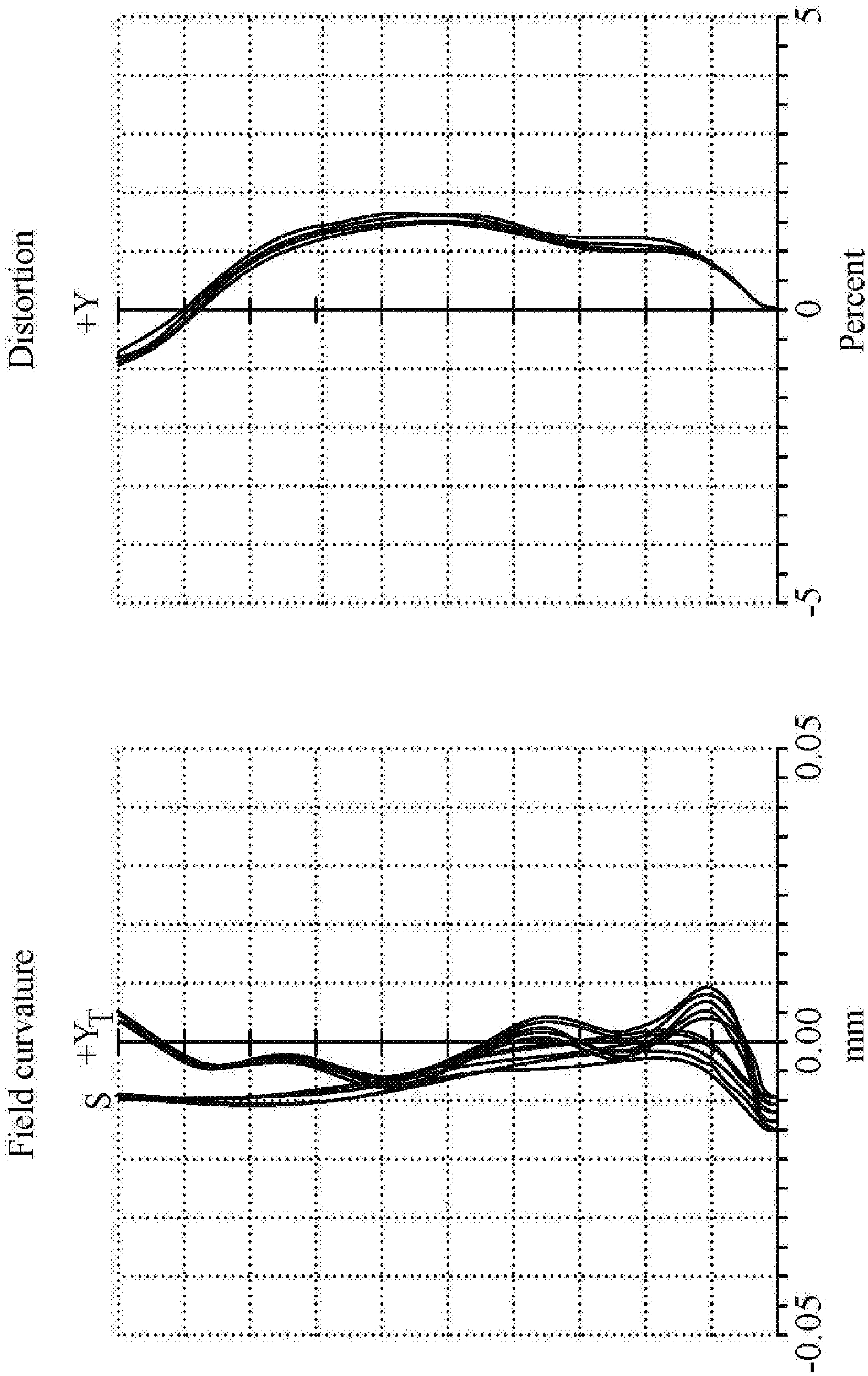


FIG. 12B

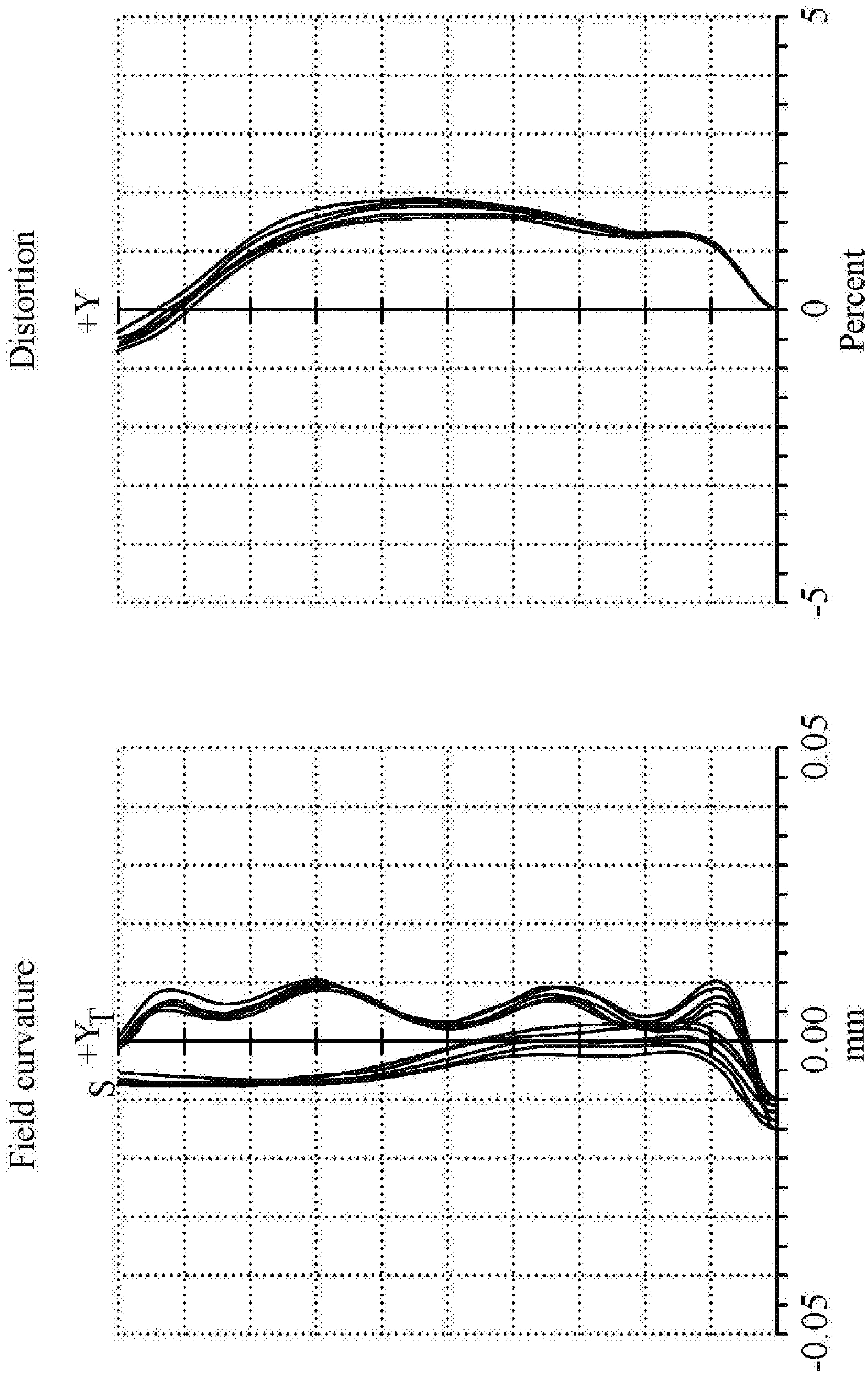
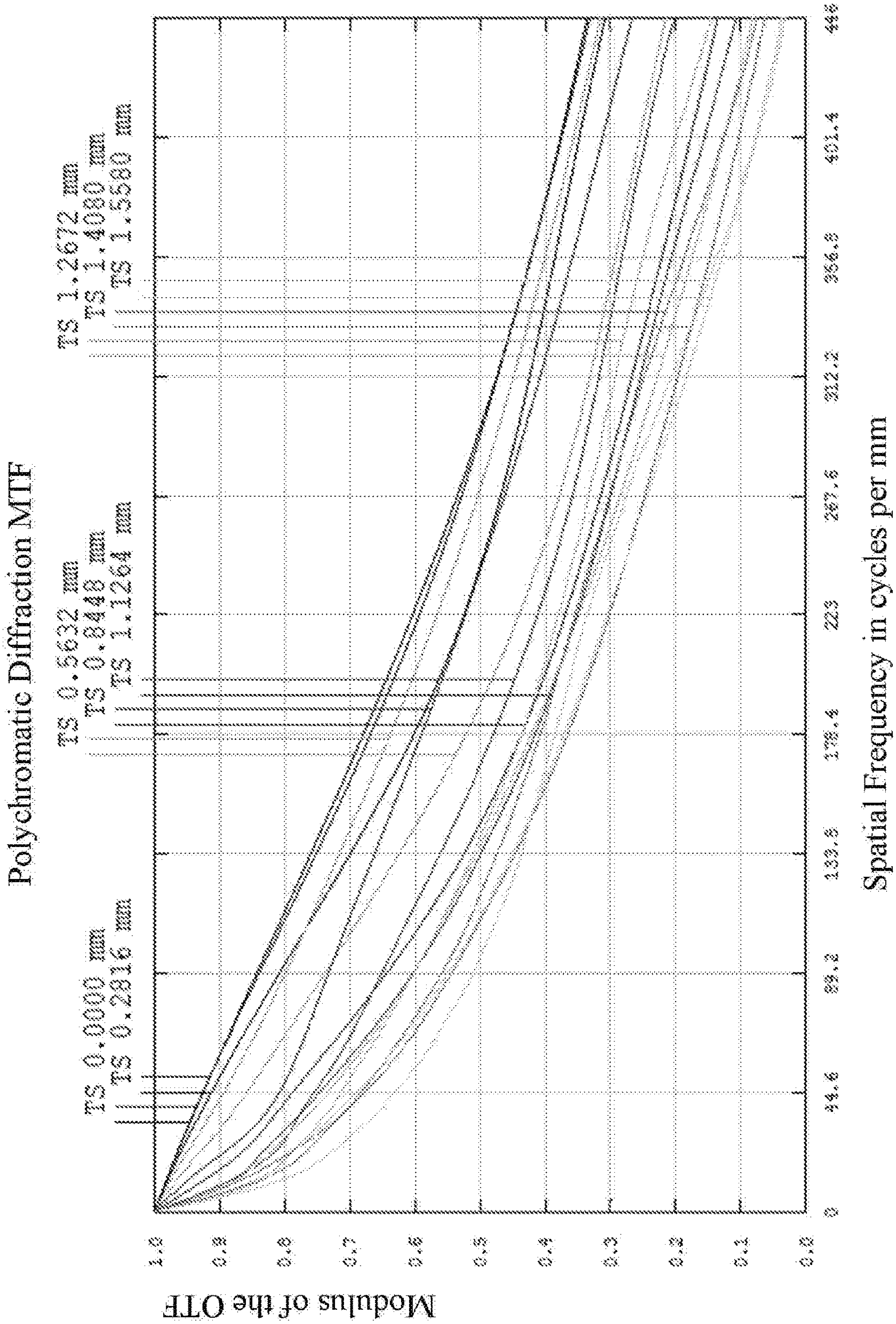


FIG. 12C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TS 0.0000 mm
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TS 0.5632 mm
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TS 1.1264 mm
TS 1.2672 mm
TS 1.4080 mm
TS 1.5580 mm
Modulus of the OTF
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
44.6
89.2
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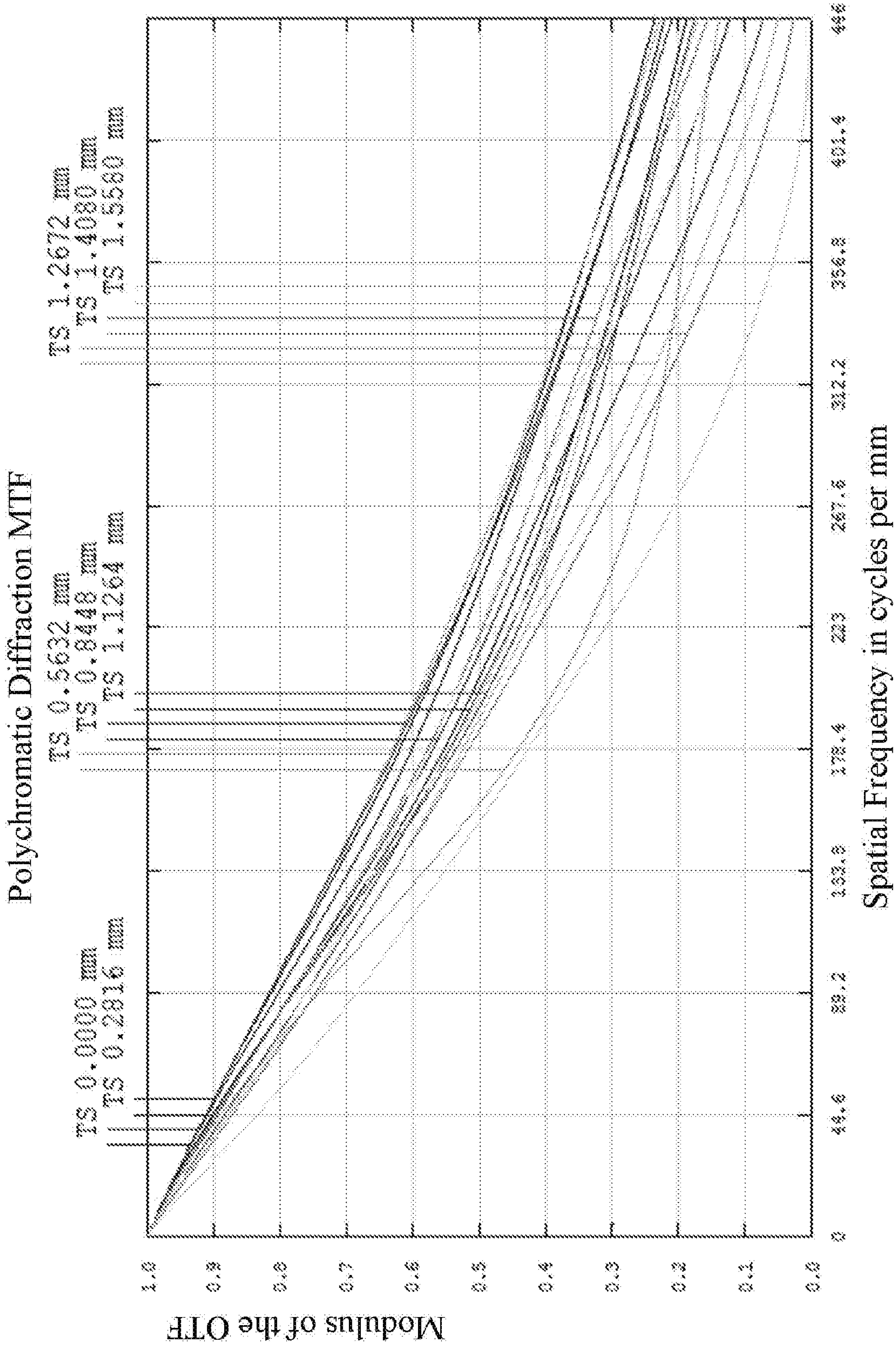
223
267.6
312.2
356.8
401.4
446
Spatial Frequency in cycles per mm

FIG. 12D


Polychromatic Diffraction MTF
TS 0.0000 mm
TS 0.2816 mm
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TS 0.8448 mm
TS 1.1264 mm
TS 1.2672 mm
TS 1.4080 mm
TS 1.5580 mm
Modulus of the OTF
Spatial Frequency in cycles per mm
0
44.6
89.2
133.8
178.4
223
267.6
312.2
356.8
401.4
446
1.0
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0.2
0.1
0.0

FIG. 12E

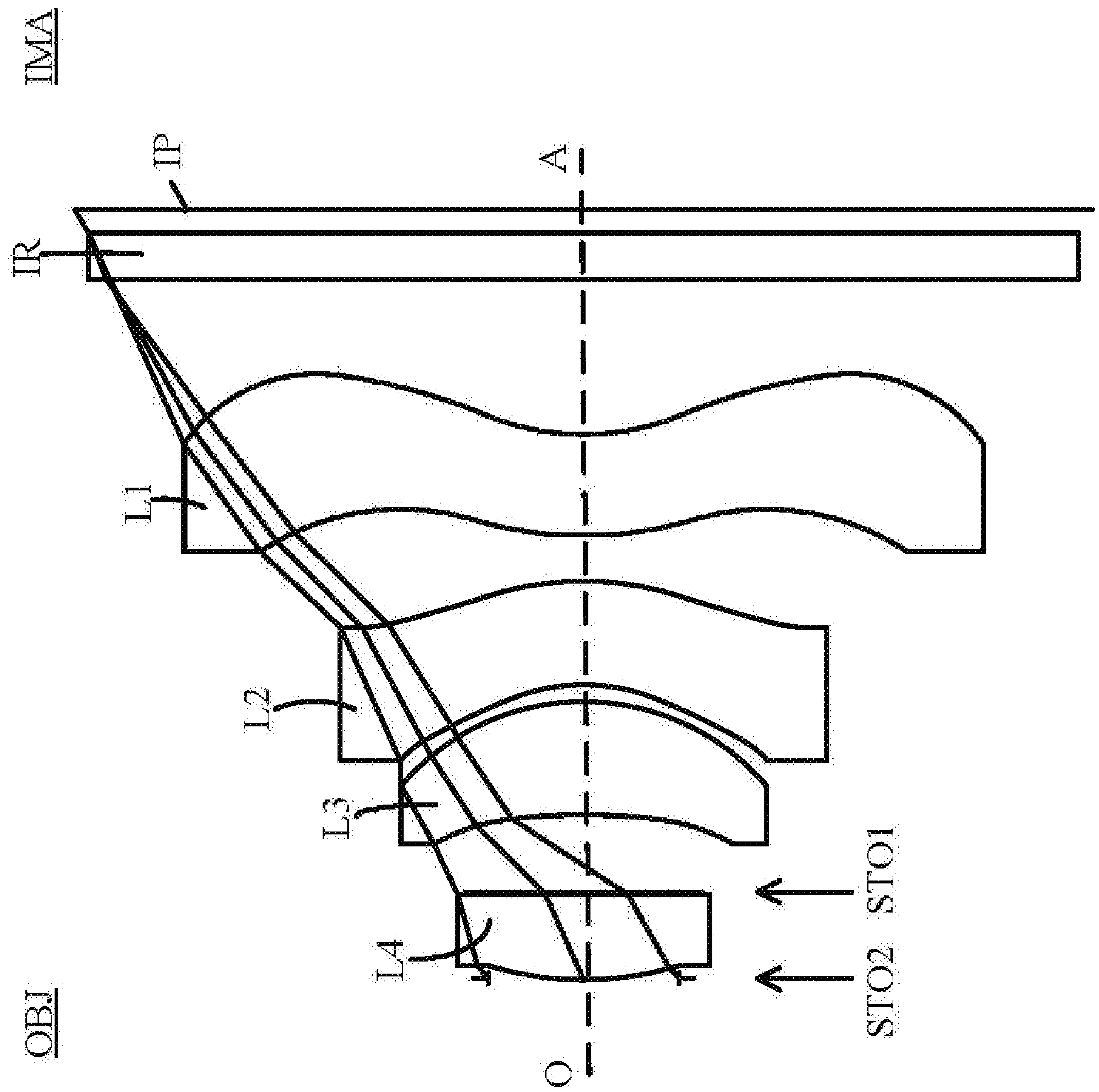


FIG. 13A

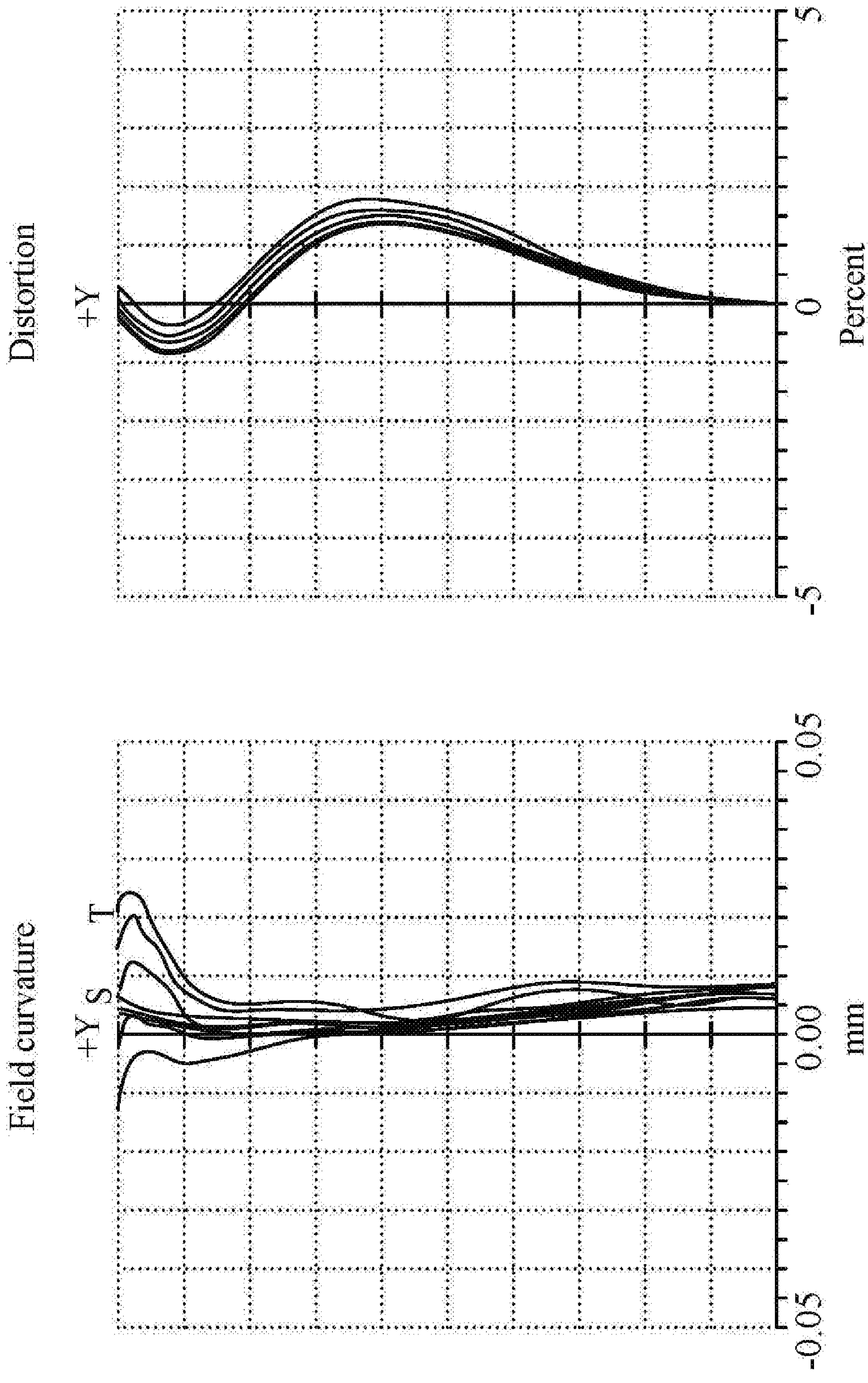


FIG. 13B

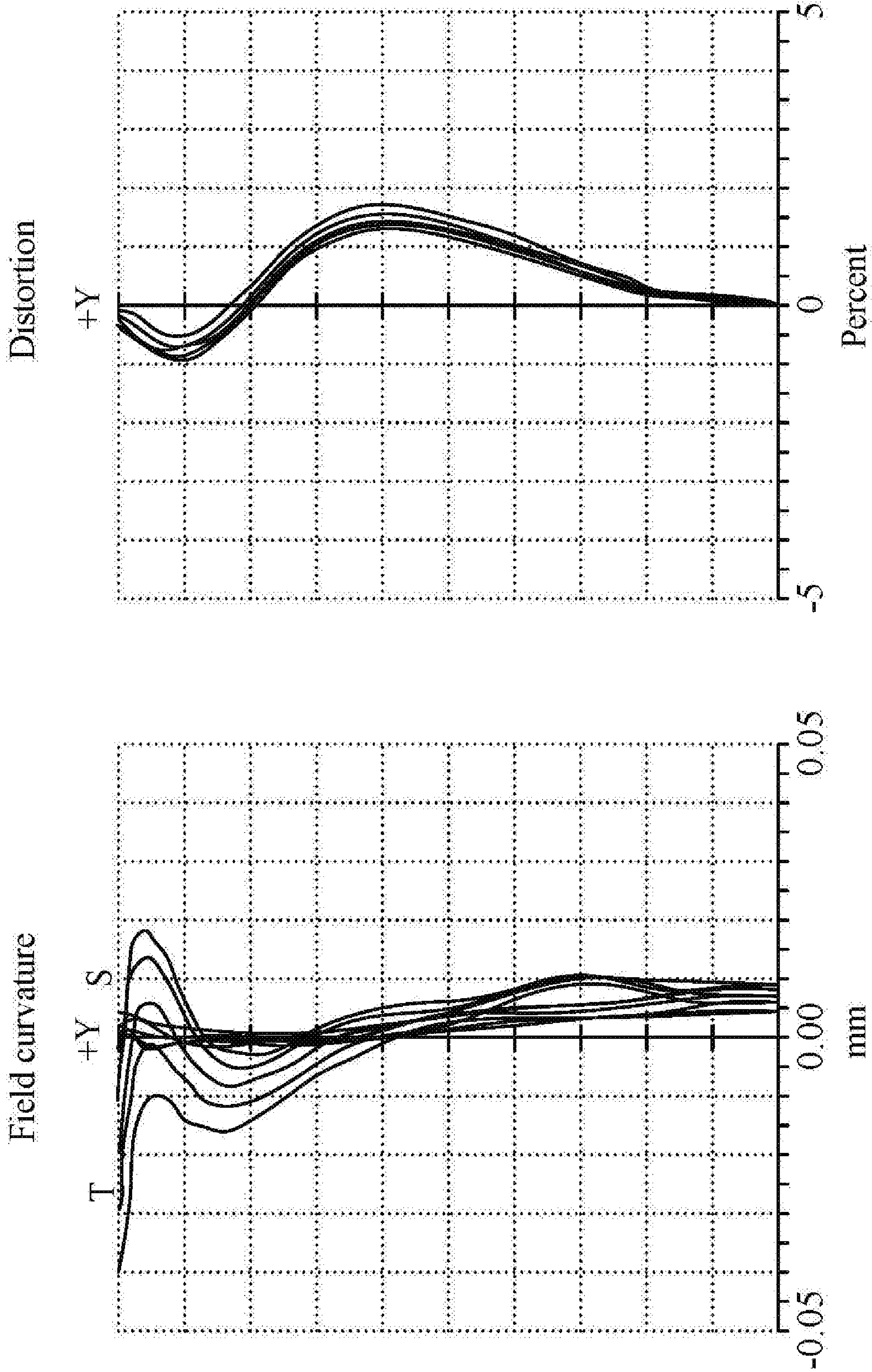
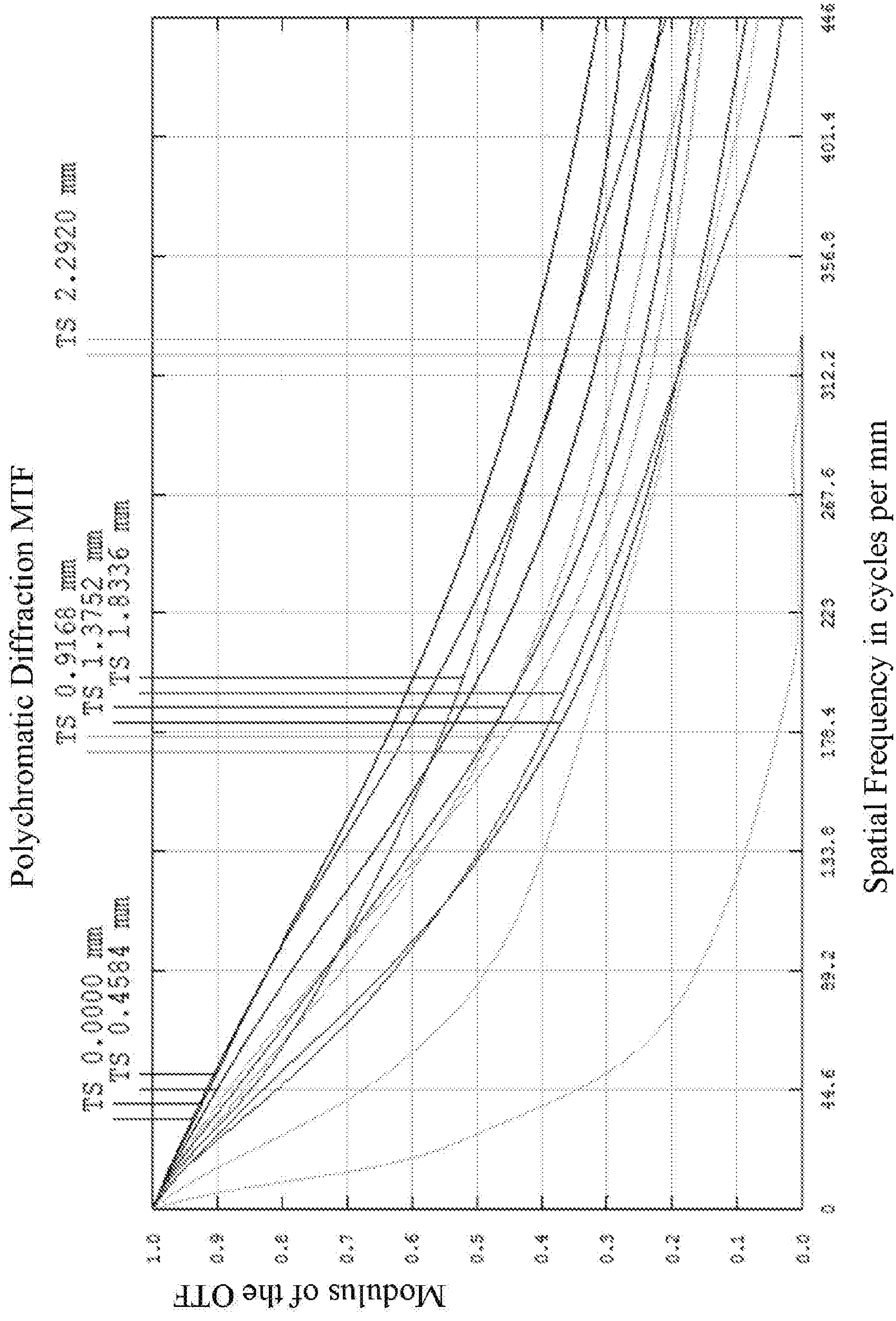


FIG. 13C


Polychromatic Diffraction MTF
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TS 0.4584 mm
TS 0.9168 mm
TS 1.3752 mm
TS 1.8336 mm
TS 2.2920 mm
Modulus of the OTF
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
44.6
89.2
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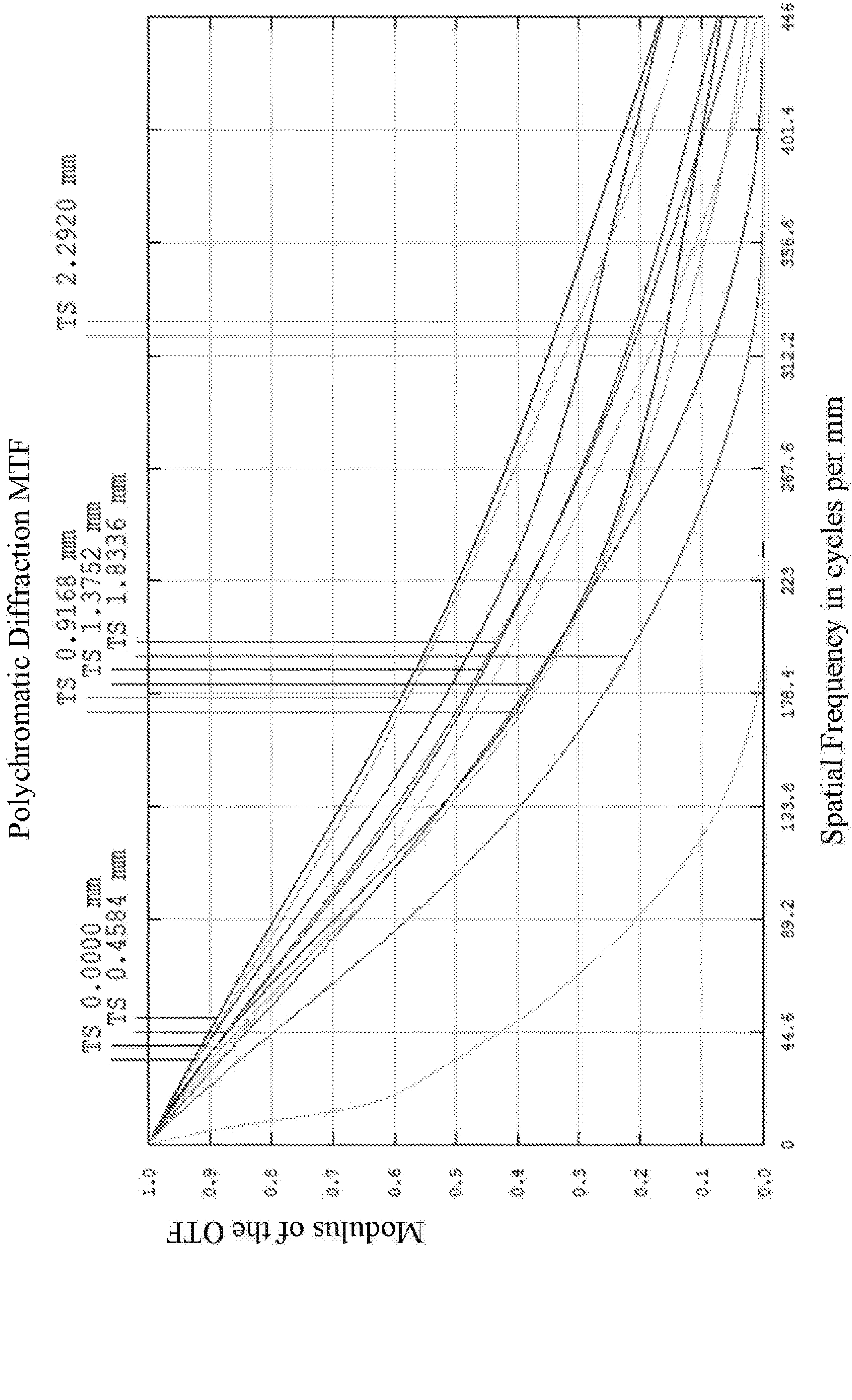
178.4
223.0
267.6
312.2
356.8
401.4
446
Spatial Frequency in cycles per mm

FIG. 13D


Polychromatic Diffraction MTF
TS 0.0000 mm
TS 0.4584 mm
TS 0.9168 mm
TS 1.3752 mm
TS 1.8336 mm
TS 2.2920 mm
Modulus of the OTF
1.0
0.9
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401.4
446
Spatial Frequency in cycles per mm

FIG. 13E

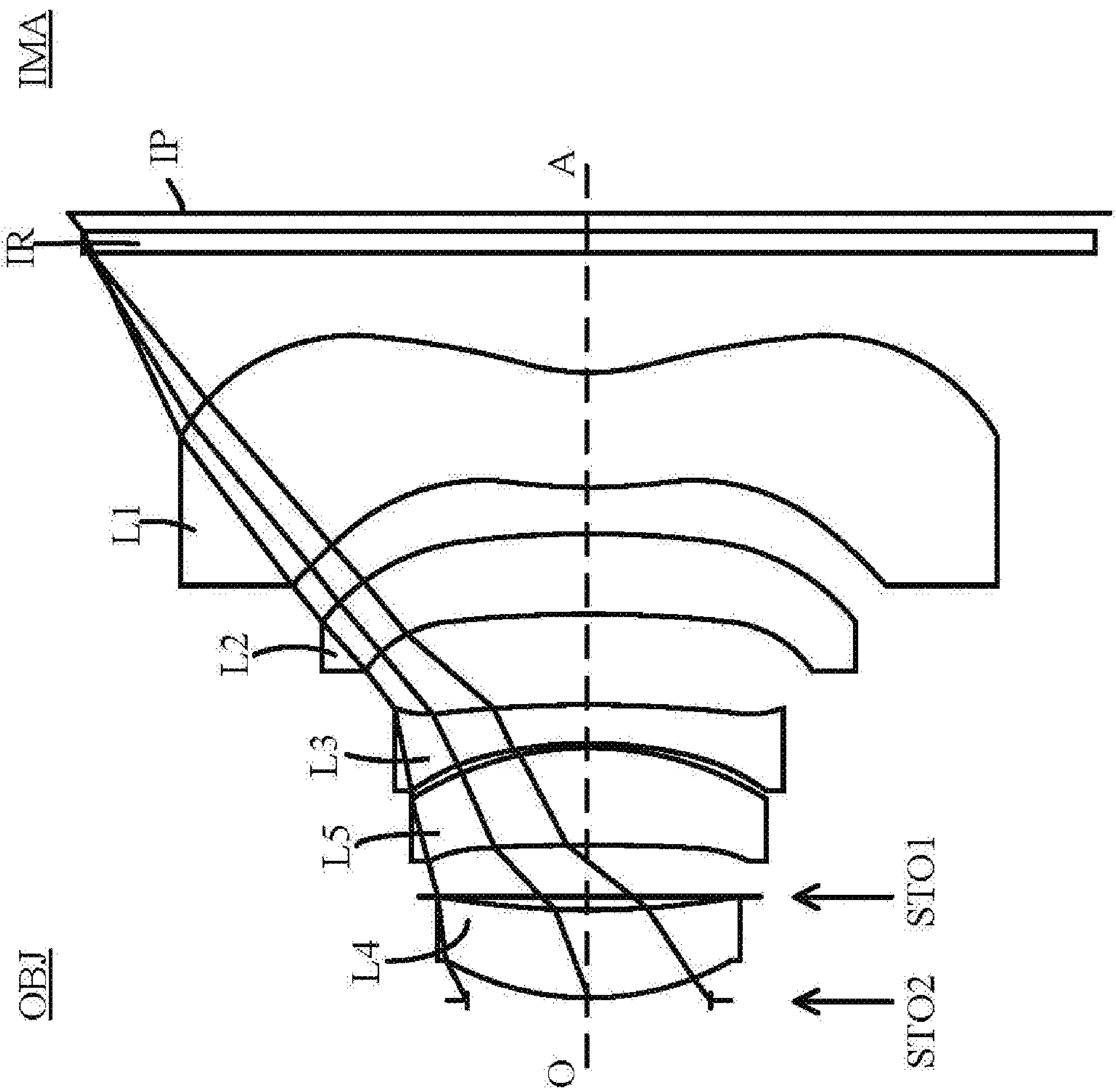


FIG. 14A

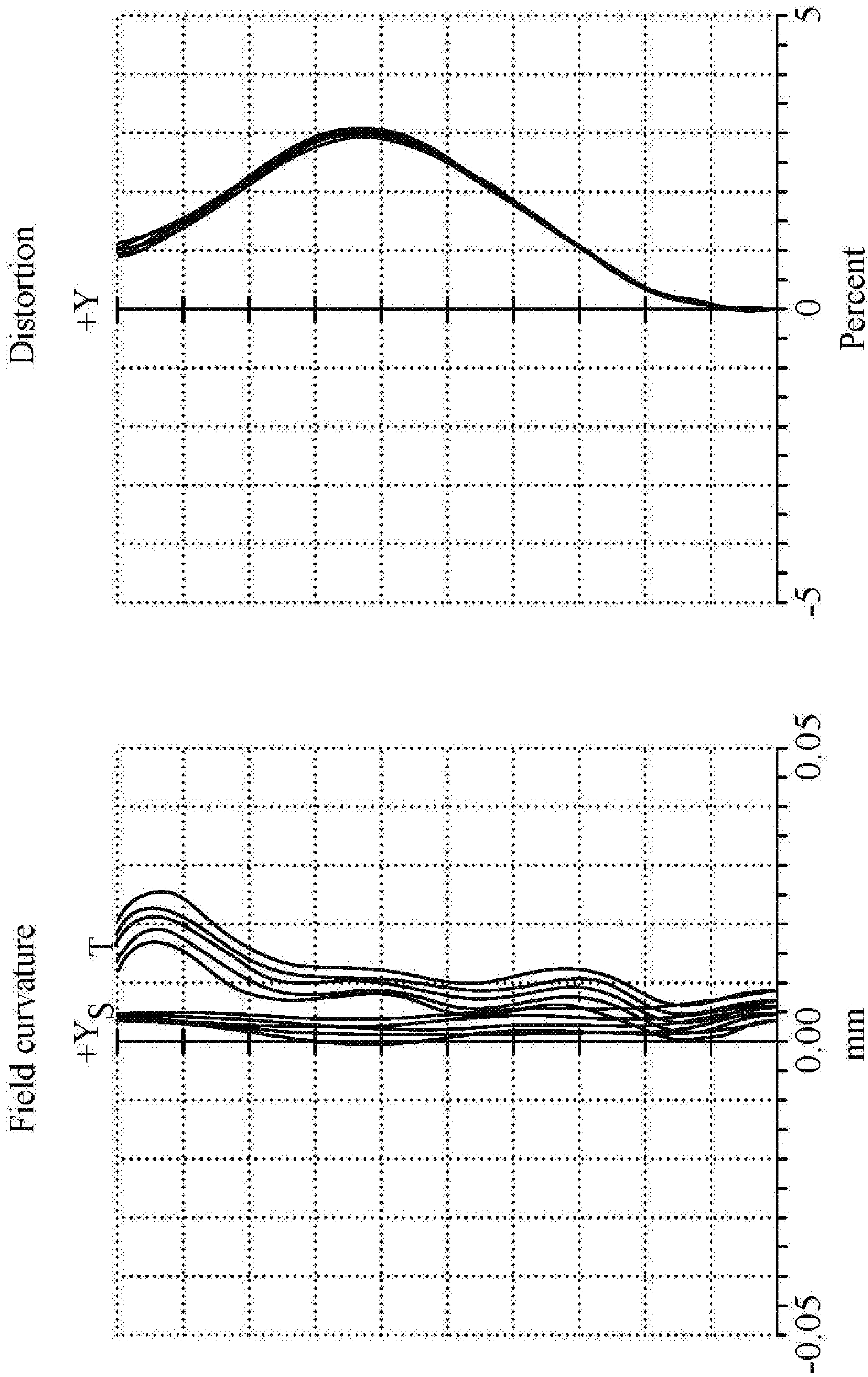


FIG. 14B

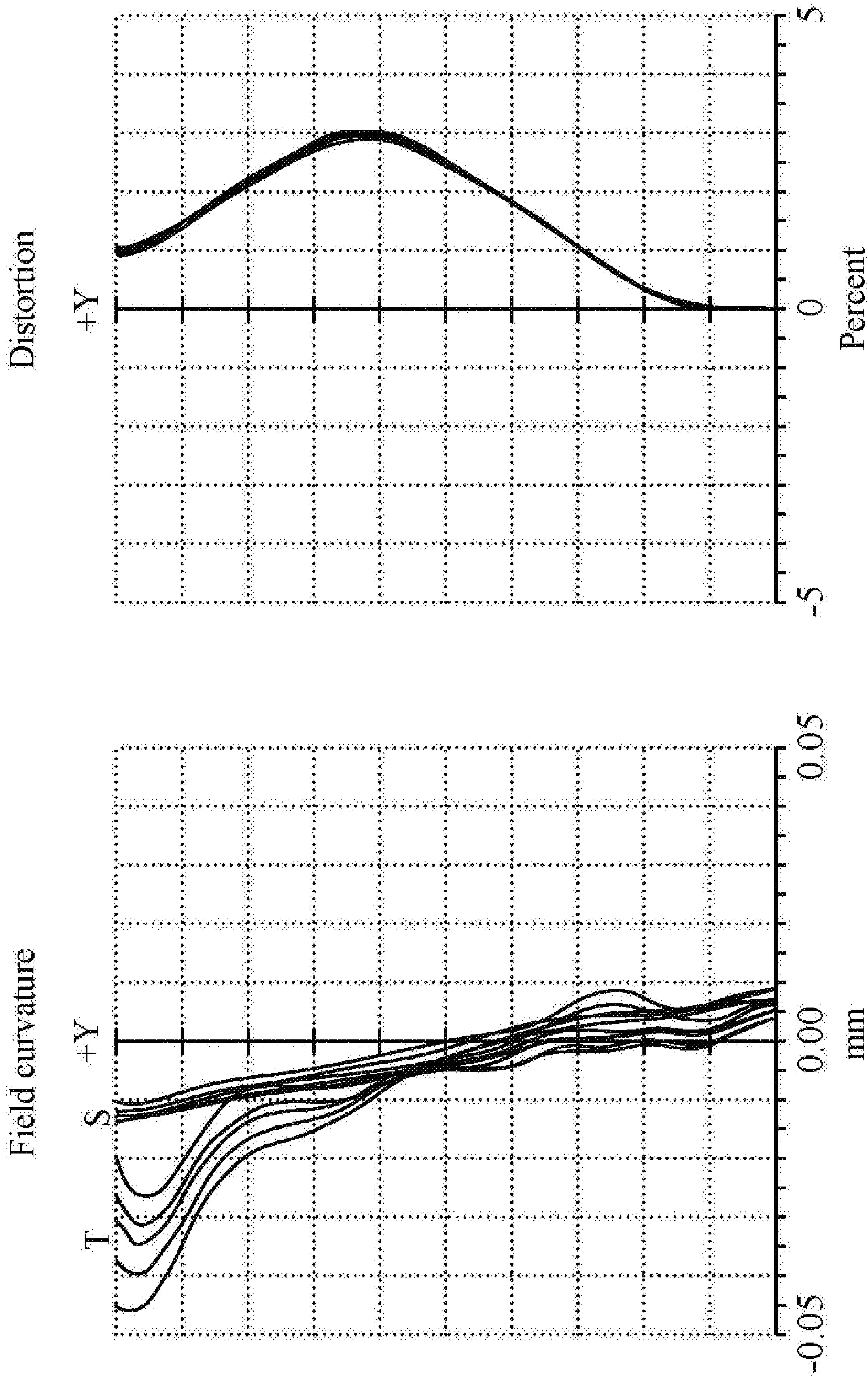
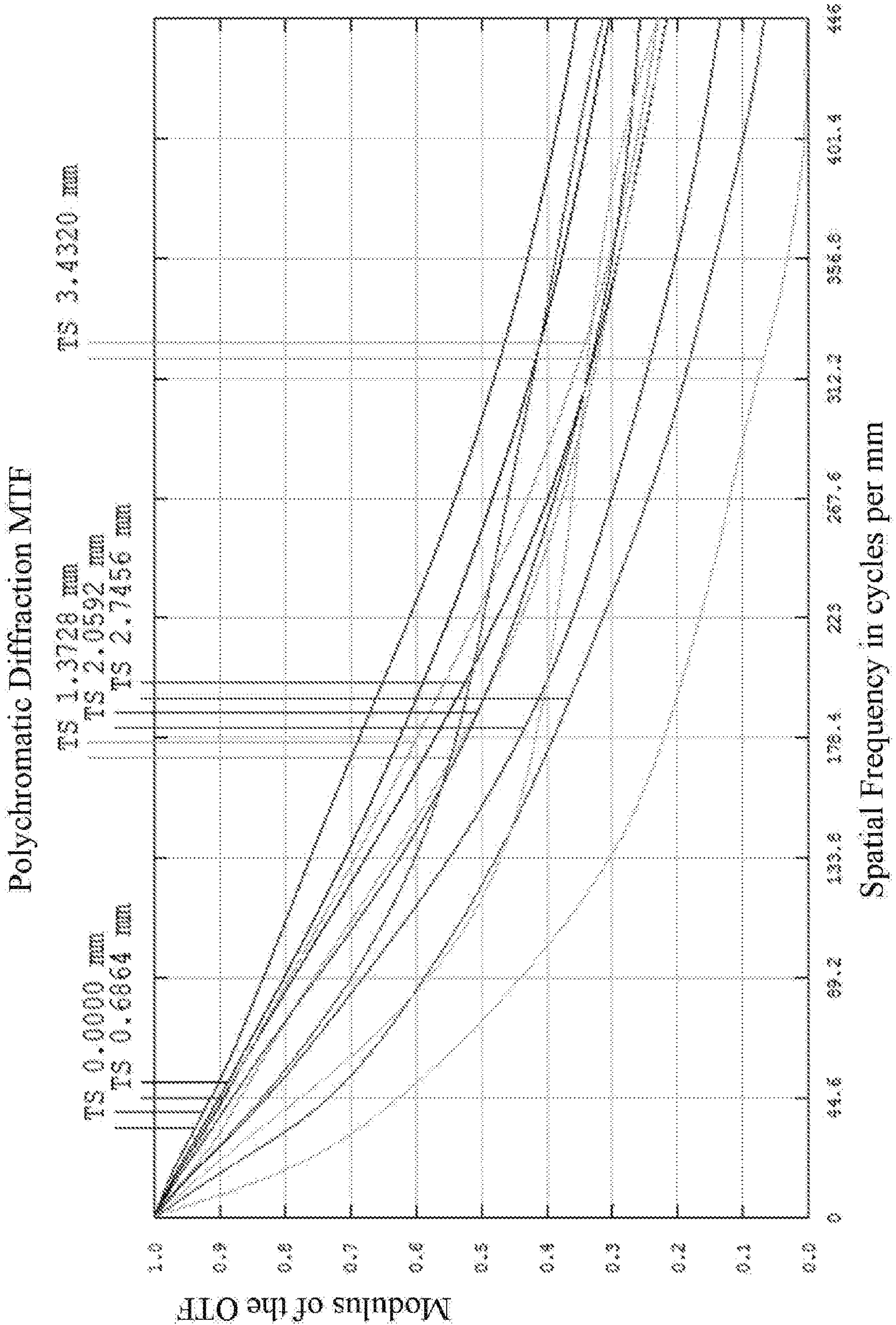


FIG. 14C


Polychromatic Diffraction MTF
TS 0.0000 mm
TS 0.6864 mm
TS 1.3728 mm
TS 2.0592 mm
TS 2.7456 mm
TS 3.4320 mm
Modulus of the OTF
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
44.6
89.2
133.8
178.4
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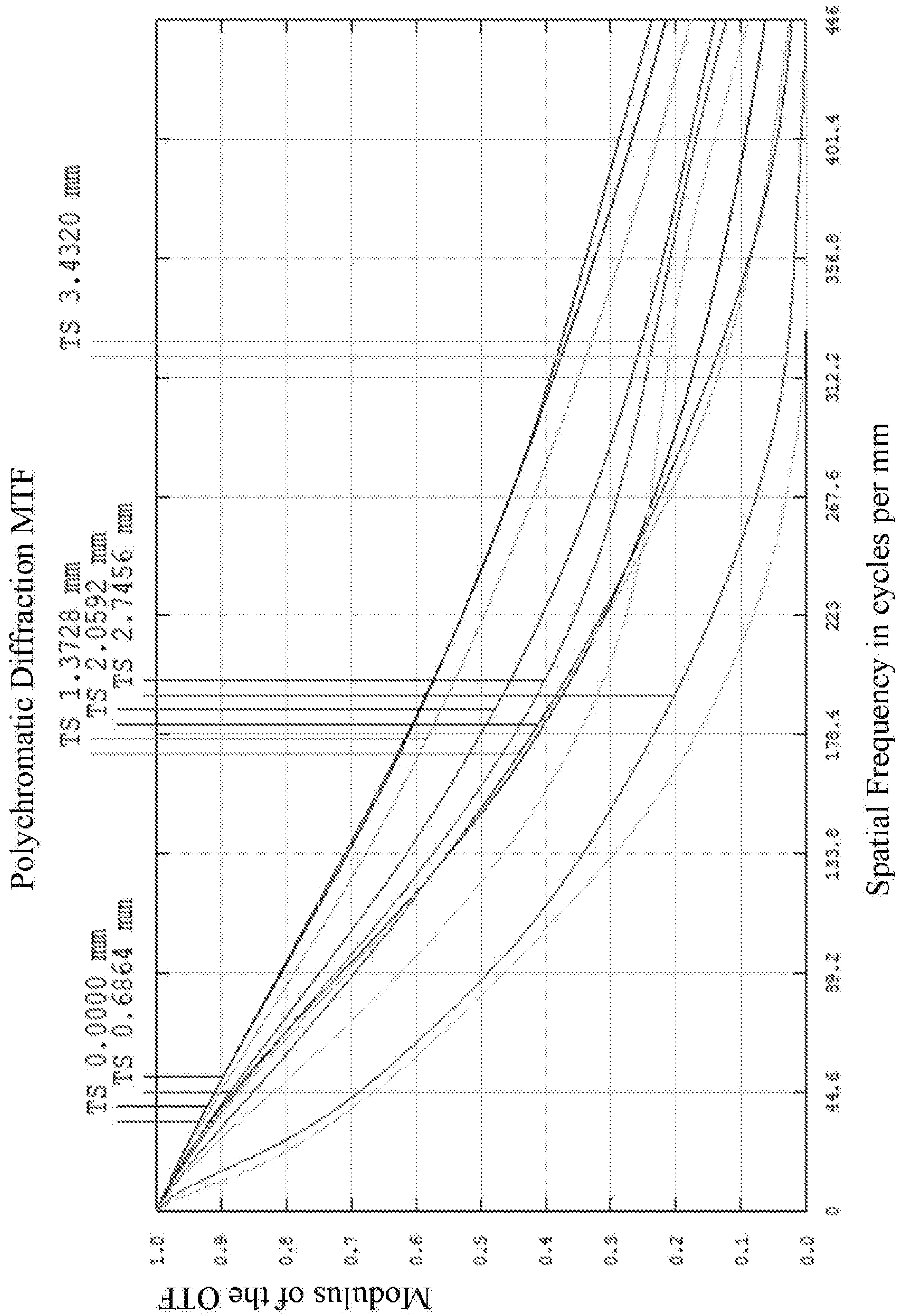
267.6
312.2
356.8
401.4
446
Spatial Frequency in cycles per mm

FIG. 14D



Polychromatic Diffraction MTF
TS 0.0000 mm
TS 0.6864 mm
TS 1.3728 mm
TS 2.0592 mm
TS 2.7456 mm
TS 3.4320 mm
Modulus of the OTF
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
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Spatial Frequency in cycles per mm

FIG. 14E

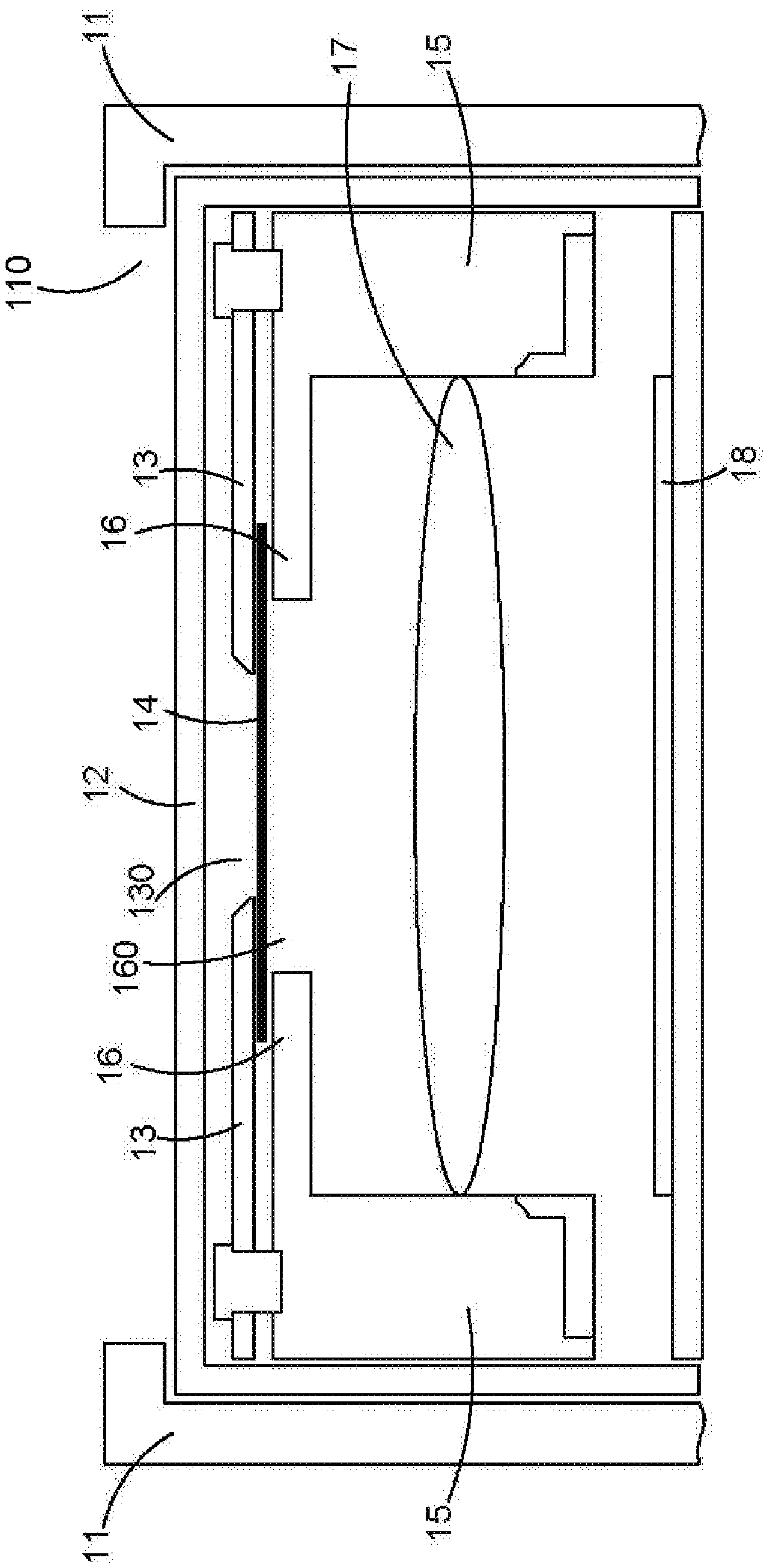

FIG. 15

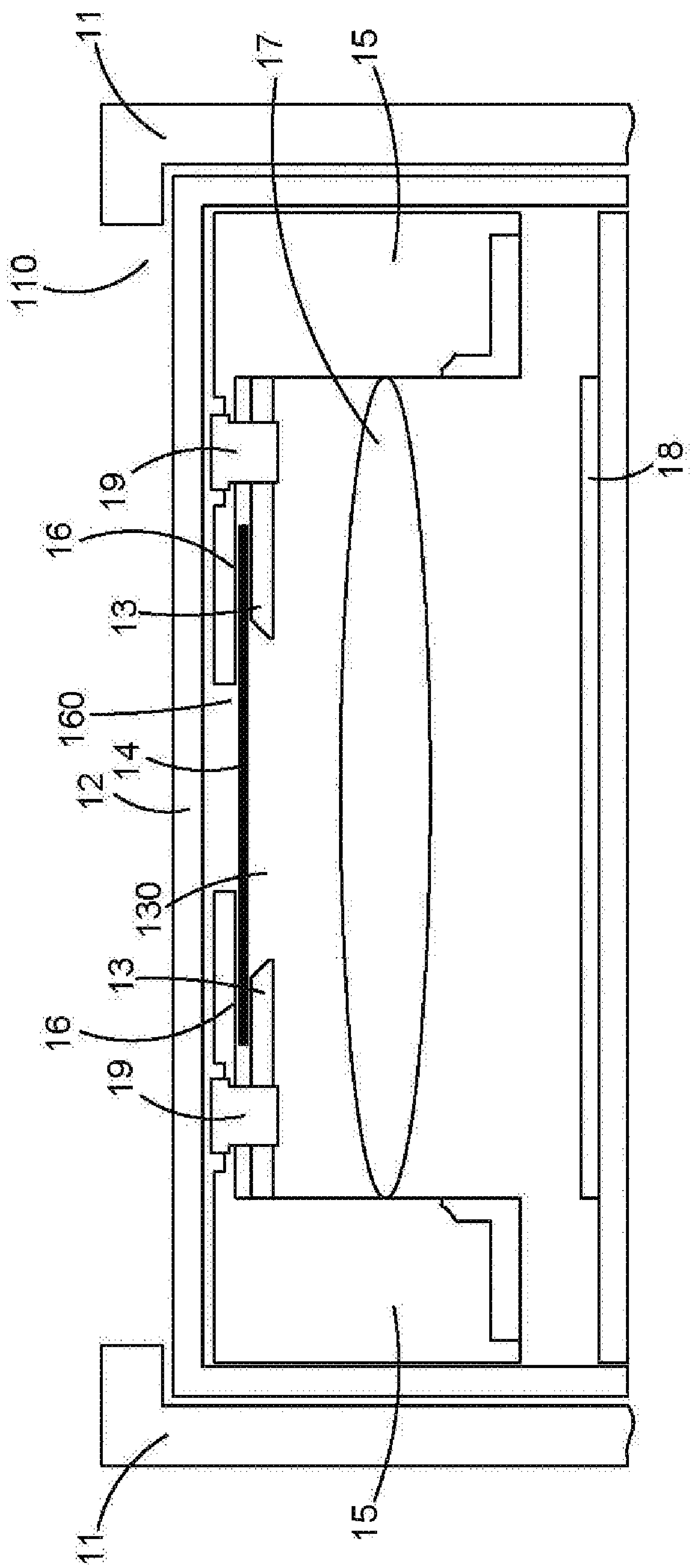

FIG. 16

CAMERA DEVICE WITH ADJUSTABLE APERTURE

TECHNICAL FIELD OF THE DISCLOSURE

The present invention relates to a camera device, and more particularly, to a camera device with an adjustable aperture

BACKGROUND OF THE DISCLOSURE

In conventional skills, an electronic apparatus equipped with a camera usually has an opening disposed on an external shell thereof. Thus, light rays can be transmitted to the lenses of the camera via the opening for facilitating image formation. Generally, such an opening will be covered by a transparent plate for preventing the dust from falling into the inner part of the electronic apparatus. However, in order to be convenient for manufacture, the transparent plate is just adhered to an external surface of the external shell in the conventional skills. Using such an approach, it is difficult to prevent the dust from falling into a blade room of an aperture adjusting device if the camera is of an aperture-adjustable type. In addition, if the size and volume of the camera can be further reduced, the thickness of the electronic apparatus equipped with the camera can be reduced as well. The thickness of conventional electronic apparatus equipped with the camera is still far from perfect.

Further, an aperture-adjustable camera is only carried out by a digital still camera or a digital camcorder, for example. Although photographic ability can be increased for a smartphone or a tablet by equipping with an external camera lens and the aperture adjustment can be carried out by the external camera lens, the aperture of a camera on a mobile terminal usually is fixed. Based on the requirement of thickness of the mobile terminal, it is a tough problem in this technical field to deploy an aperture adjusting device into the mobile terminal. However, it is quite useful if the aperture adjusting function is brought out to the mobile terminal since it can change the depth of field and improve the quality of a captured picture. Therefore, how to bring out the aperture adjusting function to the mobile terminal is an important development direction in this technical field.

SUMMARY OF THE DISCLOSURE

An objective of the present invention is to provide a camera device for solving the technical problem caused by the dust falling into a blade room of an aperture adjusting device in the conventional skills.

Another object of the present invention is to provide a camera device for reducing the thickness of an electronic apparatus equipped with the camera device.

Another object of the present invention is to provide a camera device for carrying out an adjustment of aperture of a camera lens.

In an aspect, the present invention provides a camera device, which is disposed in an electronic apparatus, the electronic apparatus having an external shell with an opening exposed, the camera device having an optical system frame and a lens system deployed in the external shell of the electronic apparatus, the lens system being mounted on the optical system frame, the camera device comprising a bottom plate fastened to the optical system frame or formed by extending from the optical system frame, a cover plate fastened to the bottom plate and distanced away from the bottom plate, at least one shutter blade disposed between the

cover plate and the bottom plate, configured to adjust an aperture of the camera device, and a transparent plate forming an accommodating space for accommodating the optical system frame, the bottom plate, and the cover plate, the transparent plate being located in the external shell and a part of the transparent plate being located between the bottom plate and the opening of the external shell, or between the cover plate and the opening of the external shell.

In another aspect, the present invention provides a camera device, which is disposed in an electronic apparatus, the electronic apparatus having an external shell with an opening exposed, the camera device having an optical system frame and a lens system deployed in the external shell of the electronic apparatus, the lens system being mounted on the optical system frame, the camera device comprising a bottom plate having a first opening, the bottom plate being fastened to the optical system frame or formed by extending from the optical system frame, the bottom plate further having a concave part formed thereon, a cover plate having a second opening, the cover plate being distanced away from the bottom plate, a fastening member having a base and an elongated part extending from the base, the base of the fastening member being accommodated in the concave part of the bottom plate, and the elongated part of the fastening member penetrating the concave part of the bottom plate and being fastened to the cover plate, and at least one shutter blade disposed between the cover plate and the bottom plate, configured to adjust an aperture of the camera device, wherein light rays are transmitted to the lens system sequentially via the opening of the external shell, the first opening of the bottom plate, and an aperture established by the shutter blade, and the second opening of the cover plate, or emitted out from the opening of the external shell in a reverse order.

In still another aspect, the present invention provides a camera device with adjustable aperture, comprising an optical system frame, a lens system mounted on the optical system frame, a plate configured to be fastened to the optical system frame or be formed by extending the optical system frame, the plate having an aperture; a shutter blade coupled to the plate, the aperture of the plate being completely pervious to light when the shutter blade is at a first position, the aperture of the plate being partially pervious to light when the shutter blade is at a second position, and a driver connecting to the shutter blade for causing a displacement of the shutter blade.

In another aspect, the present invention provides a camera device, which is disposed in an electronic apparatus, the electronic apparatus having an external shell with an opening exposed, the camera device having an optical system frame and an optical system deployed in the external shell of the electronic apparatus, the lens system being mounted on the optical system frame, the optical system comprising the present invention provides an optical lens, which makes object light rays transmit from an object side to an image side on an optical axis and form an image on an image plane, said optical lens comprising a lens group establishing the optical axis, comprising a first lens and a second lens arranged in order from the image side to the object side, wherein the first lens has an image-side surface which is a concave face and has a point of inflection arranged thereon, a first aperture stop and a second aperture stop separately located on the optical axis.

In still another aspect, the present invention provides a camera device, which is disposed in an electronic apparatus, the electronic apparatus having an external shell with an opening exposed, the camera device having an optical system frame and an optical system deployed in the external shell of the electronic apparatus, the lens system being mounted on the optical system frame, the optical system comprising a lens group establishing the optical axis, a first aperture stop disposed within the lens group and a second aperture stop disposed at the object side outside the lens group.

In another aspect, the present invention provides a camera device, which is disposed in an electronic apparatus, the electronic apparatus having an external shell with an opening exposed, the camera device having an optical system frame and a lens system deployed in the external shell of the electronic apparatus, the lens system being mounted on the optical system frame, the camera device comprising a bottom plate fastened to the optical system frame or formed by extending from the optical system frame, a cover plate fastened to the bottom plate and distanced away from the bottom plate, at least one shutter blade disposed between the cover plate and the bottom plate, configured to adjust an aperture of the camera device, and a transparent plate forming an accommodating space for accommodating the optical system frame, the bottom plate, and the cover plate, the transparent plate being located in the external shell and a part of the transparent plate being located between the bottom plate and the opening of the external shell, or between the cover plate and the opening of the external shell, wherein a lens system comprises a first lens, a first aperture stop, a second lens and a second aperture stop arranged in order from the image side to the object side.

In the embodiments of the present invention, the shutter blade of the aperture-adjustable device is deployed between the exposed opening of the external shell and the outermost lens of the lens system. Therefore, there has more room at the lateral side for accommodating the driver or other components of the aperture-adjustable device. Further, a part of the transparent plate is arranged corresponding to the opening and abuts on the external shell. The transparent plate is fastened to or adhered on the optical system frame. Every component of the camera devices is disposed in the accommodating space formed by the transparent plate. Therefore, this can further prevent the dust from falling into a blade room of the aperture-adjustable device accommodating the shutter blade and prevent a user finger from touch. In addition, the cover plate can be disposed within coverage of the bottom plate. It is easy to process the optical system frame made of a plastic material to remove or cut out some parts thereof for deploying a room accommodating the fastening member, thereby reducing the total thickness of the camera device.

In the embodiments of the present invention, the shutter blade has a hole having an aperture. The aperture of a camera lens can be adjusted by driving the shutter blade using a driver and thus making the hole move toward the optical axis and shift to a position overlapping the original aperture. There can have multiple sets of the shutter blade and the driver so as to carry out a multi-stage aperture adjustment of the camera lens. An adjustment of depth of field can thus be carried out by a selection of aperture. In addition, in the embodiments of the present invention, one shutter blade is cooperated with one driver. It is convenient in replacement when these components are malfunctioned.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic diagram showing a camera device in accordance with a first embodiment of the present invention.

FIG. **2** is a schematic diagram showing a camera device in accordance with a second embodiment of the present invention.

FIG. **3** is an exploded view of a camera device with adjustable aperture in accordance with a third embodiment of the present invention.

FIG. **4** is a schematic diagram showing that a first shutter blade and a second shutter blade are at turn-on positions in accordance with the first embodiment of the present invention.

FIG. **5** is a schematic diagram showing that the first shutter blade is at a turn-on position and the second shutter blade are at a turn-off position in accordance with the first embodiment of the present invention.

FIG. **6** is a schematic diagram showing that the first shutter blade is at a turn-off position and the second shutter blade are at a turn-on position in accordance with the first embodiment of the present invention.

FIG. **7** is an exploded view of a camera device with adjustable aperture in accordance with a fourth embodiment of the present invention.

FIG. **8** is a schematic diagram showing that a first shutter blade is at a turn-on position in accordance with the second embodiment of the present invention.

FIG. **9** is a schematic diagram showing that the first shutter blade is at a turn-off position in accordance with the second embodiment of the present invention.

FIG. **10**A is a schematic diagram showing an optical structure in accordance with a fifth embodiment of an optical lens of the present invention.

FIG. **10**B is a diagram showing the optical performance including field curvature and distortion of the optical lens according to the fifth embodiment of the present invention in the condition that a first aperture stop is in an active state and a second aperture stop is in an inactive state.

FIG. **10**C is a diagram showing the optical performance including field curvature and distortion of the optical lens according to the fifth embodiment of the present invention in the condition that the first aperture stop is in the inactive state and the second aperture stop is in the active state.

FIG. **10**D is a diagram showing polychromatic diffraction modulation transfer function (MTF) of the optical lens according to the fifth embodiment of the present invention in the condition that the first aperture stop is in the active state and the second aperture stop is in the inactive state.

FIG. **10**E is a diagram showing polychromatic diffraction modulation transfer function of the optical lens according to the fifth embodiment of the present invention in the condition that the first aperture stop is in the inactive state and the second aperture stop is in the active state.

FIG. **11**A is a schematic diagram showing an optical structure in accordance with a sixth embodiment of an optical lens of the present invention.

FIG. **11**B is a diagram showing the optical performance including field curvature and distortion of the optical lens according to the sixth embodiment of the present invention in the condition that a first aperture stop is in an active state and a second aperture stop is in an inactive state.

FIG. **11**C is a diagram showing the optical performance including field curvature and distortion of the optical lens according to the sixth embodiment of the present invention in the condition that the first aperture stop is in the inactive state and the second aperture stop is in the active state.

FIG. **11**D is a diagram showing polychromatic diffraction modulation transfer function (MTF) of the optical lens according to the sixth embodiment of the present invention in the condition that the first aperture stop is in the active state and the second aperture stop is in the inactive state.

FIG. **11**E is a diagram showing polychromatic diffraction modulation transfer function of the optical lens according to the sixth embodiment of the present invention in the condition that the first aperture stop is in the inactive state and the second aperture stop is in the active state.

FIG. **12**A is a schematic diagram showing an optical structure in accordance with a seventh embodiment of an optical lens of the present invention.

FIG. **12**B is a diagram showing the optical performance including field curvature and distortion of the optical lens according to the seventh embodiment of the present invention in the condition that a first aperture stop is in an active state and a second aperture stop is in an inactive state.

FIG. **12**C is a diagram showing the optical performance including field curvature and distortion of the optical lens according to the seventh embodiment of the present invention in the condition that the first aperture stop is in the inactive state and the second aperture stop is in the active state.

FIG. **12**D is a diagram showing polychromatic diffraction modulation transfer function (MTF) of the optical lens according to the seventh embodiment of the present invention in the condition that the first aperture stop is in the active state and the second aperture stop is in the inactive state.

FIG. **12**E is a diagram showing polychromatic diffraction modulation transfer function of the optical lens according to the seventh embodiment of the present invention in the condition that the first aperture stop is in the inactive state and the second aperture stop is in the active state.

FIG. **13**A is a schematic diagram showing an optical structure in accordance with an eighth embodiment of an optical lens of the present invention.

FIG. **13**B is a diagram showing the optical performance including field curvature and distortion of the optical lens according to the eighth embodiment of the present invention in the condition that a first aperture stop is in an active state and a second aperture stop is in an inactive state.

FIG. **13**C is a diagram showing the optical performance including field curvature and distortion of the optical lens according to the eighth embodiment of the present invention in the condition that the first aperture stop is in the inactive state and the second aperture stop is in the active state.

FIG. **13**D is a diagram showing polychromatic diffraction modulation transfer function (MTF) of the optical lens according to the eighth embodiment of the present invention in the condition that the first aperture stop is in the active state and the second aperture stop is in the inactive state.

FIG. **13**E is a diagram showing polychromatic diffraction modulation transfer function of the optical lens according to the eighth embodiment of the present invention in the condition that the first aperture stop is in the inactive state and the second aperture stop is in the active state.

FIG. **14**A is a schematic diagram showing an optical structure in accordance with a ninth embodiment of an optical lens of the present invention.

FIG. **14**B is a diagram showing the optical performance including field curvature and distortion of the optical lens according to the ninth embodiment of the present invention in the condition that a first aperture stop is in an active state and a second aperture stop is in an inactive state.

FIG. **14**C is a diagram showing the optical performance including field curvature and distortion of the optical lens according to the ninth embodiment of the present invention in the condition that the first aperture stop is in the inactive state and the second aperture stop is in the active state.

FIG. **14**D is a diagram showing polychromatic diffraction modulation transfer function (MTF) of the optical lens according to the ninth embodiment of the present invention in the condition that the first aperture stop is in the active state and the second aperture stop is in the inactive state.

FIG. **14**E is a diagram showing polychromatic diffraction modulation transfer function of the optical lens according to the ninth embodiment of the present invention in the condition that the first aperture stop is in the inactive state and the second aperture stop is in the active state.

FIG. **15** is a schematic diagram showing a package structure in accordance with a fifth embodiment of an optical lens of the present invention.

FIG. **16** is a schematic diagram showing a package structure in accordance with a sixth embodiment of an optical lens of the present invention.

DETAILED DESCRIPTION OF THE DISCLOSURE

To make the objectives, technical schemes, and technical effects of the present invention more clearly and definitely, the present invention will be described in details below by using embodiments in conjunction with the appending drawings. It should be understood that the specific embodiments described herein are merely for explaining the present invention, and as used herein, the term "embodiment" refers to an instance, an example, or an illustration but is not intended to limit the present invention. In addition, the articles "a" and "an" as used in the specification and the appended claims should generally be construed to mean "one or more" unless specified otherwise or clear from the context to be directed to a singular form. Also, in the appending drawings, the components having similar or the same structure or function are indicated by the same reference number.

Please refer to FIG. **1**, which is a schematic diagram showing a camera device **10** in accordance with a first embodiment of the present invention. The camera device **10** is disposed in an electronic apparatus. For example, cell phones, smartphones, tablet computers, wearable devices, handheld game players, and other mobile terminals equipped with a camera lens are applicable to the electronic apparatuses. The electronic apparatuses can also be implemented by cameras or video recorders having a camera lens inherently, or by apparatuses having optical systems, such as projectors. The electronic apparatus has a shell or an external shell **11**. Necessary electronic components or structural components supporting the electronic components are disposed inside the external shell **11**. The external shell **11** is the outermost shell of the electronic apparatus. The external shell **11** has an opening **110** exposed. Light rays can go into the inner space of the camera device **10** (such as an image capture device) from the opening **110** or be emitted out from the inner space of the camera device **10** (such as a projector) via the opening **110**. Taking a camera lens for example, the camera device **10** will be illustrated in the following.

As shown in FIG. **1**, the camera device **10** has an optical system frame **15**, a lens system **17**, and an image recorder **18**. The optical system frame **15** is made of a plastic material, and is a fastening component of the optical system. The components of the optical system can be mounted or fastened on the optical system frame **15**. In addition, there is only one piece of lens shown in FIG. **1** but this is merely for illustration. It can be understood that the lens system **17** may include more than one lenses. The lenses of the lens system **17** are mounted on the optical system frame **15**. The image recorder **18** is disposed on a lower plate **185** and is configured to record images. Specifically, the image recorder **18** can receive the light rays passing the lens system **17** and form an image on an image plane.

Referring to FIG. **1**, the camera device **10** having a camera lens also has a transparent plate **12**, a cover plate **13**, a bottom plate **16**, and at least one shutter blade **14**. The transparent plate **12** adopts a high-transparent material. The transparent plate **12** is disposed at an inner side of the external shell **11** and adjacent to the exposed opening **110** of the external shell **11**, and is fastened on the optical system frame **15**. The transparent plate **12** forms an accommodating space. The optical system frame **15**, the bottom plate **16**, and the cover plate **13** are placed into the accommodating space formed by the transparent plate **12**. The transparent plate **12** can be completely made of the high-transparent material. Alternatively, only a part of the transparent plate **12** corresponding to the exposed opening **110** of the external shell **11** is made of the high-transparent material, and the material of other parts is not limited. Further, a part of the transparent plate **12** is disposed between the exposed opening **110** of the external shell **11** and the cover plate **13**. The bottom plate **16** is fastened to the optical system frame **15** or extending from the optical system frame **15**. The bottom plate **16** also has an opening **16**. The cover plate **13** is a metal flat plate, and is perforated to form an opening **130** in the center such that light rays can transmit into the optical system. The cover plate **13** is distanced away from the bottom plate **16**, and is fastened to the bottom plate **16** or the optical system frame **15**. A screw **19** may be used to fasten the cover plate **13** to the bottom plate **16** or the optical system frame **15**. The shutter blade **14** is a part of components of an aperture adjusting device of the camera lens, and is driven by a driver of the aperture adjusting device. The size of aperture is adjusted by adjusting the position of the shutter blade **14**. The shutter blade **14** is disposed between the cover plate **13** and the bottom plate **16** fastened to the optical system frame **15** or extending from the optical system frame **15**, and is configured to adjust the aperture. It is known that as to the package framework of the camera device **10**, a part of the transparent plate **12**, the cover plate **13**, the shutter blade **14**, the bottom plate **16**, the lens system **17**, and the image recorder **18** are arranged in order from the exposed opening **110** of the external shell **11** to the lower plate **185**. In addition, the light rays transmit into the lens system **17** sequentially via the exposed opening **110** of the external shell **11**, a part of the transparent plate **12**, the opening **130** of the cover plate **13**, the aperture established by the shutter blade **14**, and the opening **160** of the bottom plate **16**. In other applications (e.g., projectors), the light rays may be emitted out from the exposed opening **110** of the external shell **11** in a reverse order.

In addition, the lens system **17** may include at least two pieces of lenses and an aperture stop disposed between the two lenses or between the set of the two lenses and the image plane. For instance, the aperture established by the shutter blade **14** is an adjustable aperture while the aperture of the aperture stop arranged in the lens system **17** is a fixed aperture. The aperture established by the shutter blade **14** is smaller than or equal to the aperture of the aperture stop arranged in the lens system **17**. The aperture of the optical system is defined by the aperture established by the shutter blade **14** when a small aperture is required by the optical system. The aperture of the optical system is defined by the aperture of the aperture stop arranged in the lens system **17** when a large aperture is required by the optical system. For instance, when a small aperture is required, the aperture established by the shutter blade **14** is adjusted to decrease the size of aperture thereof. The aperture stop arranged in the lens system **17** ceases to be effective due to the evolution of light path and is thus in an inactive state. When a large aperture is required, the aperture established by the shutter blade **14** is adjusted to be equal to the aperture of the aperture stop arranged in the lens system **17**, and meanwhile the aperture of the optical system is defined by the aperture of the aperture stop arranged in the lens system **17**. In this way, an aperture-adjustable device having the shutter blades **14** can be deployed at the outer side of the lens at the most object side. Since there has more room for accommodating such an aperture-adjustable device in this configuration, the size of the camera device **10** can be reduced.

In the embodiments of the present invention, the shutter blade **14** of the aperture-adjustable device is deployed between the exposed opening **110** of the external shell **11** and the outermost lens of the lens system **17**. Therefore, there has more room at the lateral side for accommodating the driver or other components of the aperture-adjustable device. If the shutter blade **14** of the aperture-adjustable device is arranged between any two lenses, the deployment of the driver or other components of the aperture-adjustable device will be limited and such a deployment is more complicated and inconvenient. Further, in the embodiments of the present invention, a part of the transparent plate **12** is arranged corresponding to the opening **110** and abuts on the external shell **11**. The transparent plate **12** is fastened to or adhered on the optical system frame **15**. Every component of the camera devices is disposed in the accommodating space formed by the transparent plate **12**. Therefore, this can further prevent the dust from falling into a blade room of the aperture-adjustable device accommodating the shutter blade **14** and prevent a user finger from touch.

The differences between the camera device **20** of the second embodiment and the camera device **10** of the first embodiment are that in the second embodiment of the present invention, the cover plate **13** is disposed within coverage of the bottom plate **16**, and the bottom plate **16** is arranged at an upper side while the cover plate **13** is changed in its position to be at a lower side. A fastening member (e.g., a screw) **19** is utilized to fasten the cover plate **13** to the bottom plate **16** or the optical system frame **15**. The shutter blade **14** is accommodated between the cover plate **13** and the bottom plate **16**. Specifically, the bottom plate **16** has a concave part **161**. The fastening member **19** has a base **191** and an elongated part **192** extending from the base **191**. The base **191** of the fastening member **19** is accommodated into the concave part **161** of the bottom plate **161**. The elongated part **192** of the fastening member **19** penetrates the concave part **161** of the bottom plate **16** and is fastened on the cover plate **13**. In addition, as to the package framework of the camera device **20**, a part of the transparent plate **12**, the bottom plate **16**, the shutter blade **14**, the cover plate **13**, the lens system **17**, and the image recorder **18** are arranged in order from the exposed opening **110** of the external shell **11** to the lower plate **185**. In addition, the light rays transmit into the lens system **17** sequentially via the exposed opening **110** of the external shell **11**, a part of the transparent plate **12**, the opening **160** of the bottom plate **16**, the aperture established by the shutter blade **14**, and the opening **130** of the cover plate **13**. In other applications (e.g., projectors), the light rays may be emitted out from the exposed opening **110** of the external shell **11** in a reverse order. The advantages of such a technical scheme are that it is easy to process the optical system frame **15** made of a plastic material to remove or cut out some parts thereof for deploying a room accommodating the fastening member, thereby reducing the total thickness of the camera device.

The present invention can also have the camera device equipped with a aperture adjusting function such that an adjustment of depth of field can be carried out by a selection of aperture when a user takes pictures using the camera device on a mobile terminal, for example.

Please refer to FIG. **3**, which is an exploded view of a camera device with adjustable aperture in accordance with a third embodiment of the present invention. As shown in FIG. **3**, the camera device of the third embodiment of the present invention includes a supporting base **22**, a driver supporting base **24**, and a lens supporting base **26**. The camera device further includes a first shutter blade **31**, a second shutter blade **32**, a cover plate **33**, a bottom plate **34**, a first driver **35**, a second driver **36**, a lens system **37**, and an image recorder **38**. As shown in the embodiment depicted in FIG. **3**, the first shutter blade **31**, the second shutter blade **32**, the cover plate **33**, and the bottom plate **41** can be mounted on the supporting base **22**. The first driver **35** and the second driver **36** can be mounted on the driver supporting base **24**. The lens system **37** and the image recorder **38** can be deployed on the lens supporting base **26**.

It should be noted that the afore-described deployment is merely for illustration, and the supporting base **22**, the driver supporting base **24**, and the lens supporting base **26** may not be clearly distinguished. They can be deemed as an optical system frame, or any two of them can be combined into one entity, or at least two of the supporting base **22**, the driver supporting base **24**, and the lens supporting base **26** or all of them are integratedly formed or made of a same material. In this way, the size of overall camera device can be reduced. For instance, the driver supporting base **24** and the lens supporting base **26** can be manufactured to be an integratedly-formed supporting base.

Specifically, the bottom plate **34** is fastened on the supporting base **22**. Alternatively, the bottom plate **34** can also be formed by extending from the supporting base **22**, or is just a part of the supporting base **22**. The cover plate **33** is distanced a part from the bottom plate **34**. Preferably, the cover plate **33** is fastened to the supporting base **22**. Various types of ways may be utilized to fasten the cover plate **33** to the supporting base **22**. For instance, the cover plate **33** has some branches while supporting base **22** has slots corresponding to the branches. By engaging the branches and the slots, the cover plate **33** can thus be fastened on the supporting base **22**.

The cover plate **33** and the bottom plate **34** are separated from each other. An accommodating space is formed between the cover plate **33** and the bottom plate **34**, and is configured to accommodate the first shutter blade **31** and the second shutter blade **32**, which are utilized to change or adjust the effective aperture of the camera device. In addition, as shown in FIG. **3**, the driver supporting base **24** has a first accommodating room **241** and a second accommodating room **242** for accommodating the first driver **35** and the second driver **36**, respectively. The first driver **35** is configured to drive the first shutter blade **31** and bring about a displacement of the first shutter blade **31**, and the second driver **36** is configured to drive the second shutter blade **32** and bring about a displacement of the second shutter blade **32**, thereby changing or adjusting the effective aperture of the camera device. Preferably, the first driver **35** and the second driver **36** are implemented by an electric motor such as a current-control-type electric motor. The first driver **35** and the second driver **36** can adopt a structure or configuration as the same as that of a conventional electric motor.

As shown in FIG. **3**, the supporting base **22** has a first axle rod **221**, and the first shutter blade **31** has a first axle hole **311** disposed corresponding to the position of the first axle rod **221**. The bottom plate **34** and the cover plate **33** are perforated to form holes in corresponding positions. The first axle rod **221** penetrates the corresponding holes of the bottom plate **34** and the cover plate **33** and the first axle hole **311** of the first shutter blade **31**. Alternatively, the bottom plate **34** and the cover plate **33** are manufactured with a configuration that is not prohibiting the first axle rod **221** from going through the first axle hole **311** of the first shutter blade **31**. In this way, by using the deployment of the first axle rod **221** and the first axle hole **311**, the first shutter blade **31** can pivot about an axial of the first axle rod **221**.

Correspondingly, the supporting base **22** has a second axle rod **222**, and the second shutter blade **32** has a second axle hole **321** disposed corresponding to the position of the second axle rod **222**. The bottom plate **34** and the cover plate **33** are perforated to form holes in corresponding positions. The second axle rod **222** penetrates the corresponding holes of the bottom plate **34** and the cover plate **33** and the second axle hole **321** of the second shutter blade **32**. Alternatively, the bottom plate **34** and the cover plate **33** are manufactured with a configuration that is not prohibiting the second axle rod **222** from going through the second axle hole **321** of the second shutter blade **32**. In this way, by using the deployment of the second axle rod **222** and the second axle hole **321**, the second shutter blade **32** can pivot about an axial of the second axle rod **222**.

The first driver **35** has a first rotating rod **351** disposed thereon. The first rotating rod **351** is driven by the first driver **35** and thus moves in an arc orbit. The first driver **35** can make the first rotating rod **351** move circularly or in an arc fashion. An appropriate transmission mechanism or structure can be deployed between the first driver **35** and the first rotating rod **351**. For instance, the first rotating rod **351** is protruded from the surface of a disc, and the disc transfers the force of a rotation generated by the first driver **35** by using a wheel gear. The supporting base **22** has a first orbital hole **223** disposed corresponding to the arc orbit of the first rotating rod **351** of the first driver **35**, and the first shutter blade **31** has a first applying hole **312**, correspondingly. The bottom plate **34** and the cover plate **33** has holes in corresponding positions. The first rotating rod **351** of the first driver **35** penetrates the first orbital hole **223** of the supporting base **22**, the corresponding holes of the bottom plate **34** and the cover plate **33** and the first applying hole **312** of the first shutter blade **31**. The first applying hole **312** can also be configured to be intersect with the first orbital hole **223**. Of course, the bottom plate **34** and the cover plate **33** can also be configured not to affect the movement of the first rotating rod **351**. When the first rotating rod **351** rotates under control of the first driver **35**, the first rotating rod **351** moves from a first position to a second position within the first orbital hole **223** of the supporting base **22**. Meanwhile, the first rotating rod **351** applies a force to the first shutter blade **31** through the first applying hole **312**, thereby generating a torque for the first shutter blade **31** in a first direction. Thus, the first shutter blade **31** rotates around the first axel rod **221** from a turn-on position to a turn-off position, for example. When the first rotating rod **351** moves from the second position to the first position within the first orbital hole **223**, the first rotating rod **351** gives to the first shutter blade **31** a torque of a second direction opposite to the first direction. Meanwhile, the first shutter blade **31** rotates from the turn-off position to the turn-on position, for example.

Similarly, the second driver **36** has a second rotating rod **361** disposed thereon. The second rotating rod **361** is driven by the second driver **36** and thus moves in an arc orbit. An appropriate transmission mechanism or structure can be deployed between the second driver **36** and the second rotating rod **361** such that the second driver **36** can make the second rotating rod **361** move circularly or in an arc fashion. The supporting base **22** has a second orbital hole **224** disposed corresponding to the arc orbit of the second rotating rod **361** of the second driver **36**, and the second shutter blade **32** has a second applying hole **322**, correspondingly. The bottom plate **34** and the cover plate **33** has holes in corresponding positions. The second rotating rod **361** of the second driver **36** penetrates the second orbital hole **224** of the supporting base **22**, the corresponding holes of the bottom plate **34** and the cover plate **33** and the second applying hole **322** of the second shutter blade **32**. The second applying hole **322** can also be configured to be intersect with the second orbital hole **224**. Of course, the bottom plate **34** and the cover plate **33** can also be configured not to affect the movement of the second rotating rod **361**. When the second rotating rod **361** rotates under control of the second driver **36**, the second rotating rod **361** moves from a first position to a second position within the second orbital hole **224** of the supporting base **22**. Meanwhile, the second rotating rod **361** applies a force to the second shutter blade **32** through the second applying hole **322**, thereby generating a torque for the second shutter blade **32** in a first direction. Thus, the second shutter blade **32** rotates around the second axel rod **222** from a turn-on position to a turn-off position, for example. When the second rotating rod **361** moves from the second position to the first position within the second orbital hole **224**, the second rotating rod **361** gives to the second shutter blade **32** a torque of a second direction opposite to the first direction. Meanwhile, the second shutter blade **32** rotates from the turn-off position to the turn-on position, for example.

The bottom plate **34**, the cover plate **33**, and the supporting base **22** respectively has openings **340**, **330**, and **220** arranged along an optical axis of the camera device, for the entrance of light rays. The aperture of the camera device can be defined by an opening of a plate, which can be implemented by any one of the bottom plate **34**, the cover plate **33**, and the supporting base **22**, or by other components having an opening on the optical axis. The overall aperture of the camera decreases when such an opening is blocked and thus decreases in size.

As shown in FIG. **3**, the first shutter blade **31** further includes a first arc contour **310** and a first hole O**1** having a first aperture, and the second shutter blade **32** further includes a second arc contour **320** and a second hole O**2** having a second aperture. The size of the first hole O**1** of the first shutter blade **31** and the size of the second hole O**2** of the second shutter blade **32** are different from the aperture size defined by the plate, or are smaller than the aperture size of the plate. Also, the first aperture of the first hole O**1** of the first shutter blade **31** is different from the second aperture of second hole O**2** of the second shutter blade **32**. As shown in FIG. **3**, in one example, the first aperture of the first shutter blade **31** is smaller than the second aperture of the second shutter blade **32**.

For instance, when the first shutter blade **31** is at the turn-on position, the aperture of the plate is completely pervious to light; when the first shutter blade **31** is at the turn-off position, the aperture of the plate is partially pervious to light. Similarly, when the second shutter blade **32** is at the turn-on position, the aperture of the plate is completely pervious to light; when the second shutter blade **32** is at the turn-off position, the aperture of the plate is partially pervious to light.

Please refer to FIG. **4** with reference to FIG. **3**. For instance, when the first driver **35** drives the first shutter blade **31** and makes it be located at the turn-on position and the second driver **36** drives the second shutter blade **32** and makes it be located at the turn-on position, the first arc contour **310** of the first shutter blade **31** will park at a position corresponding to a part of contours of the openings **340**, **330**, and **220** respectively of the bottom plate **34**, the cover plate **33**, and the supporting base **22** and the second arc contour **320** of the second shutter blade **32** will park at a position corresponding to the other part of contours of the openings **340**, **330**, and **220** respectively of the bottom plate **34**, the cover plate **33**, and the supporting base **22**. That is, the aperture of the overall camera device is unchanged at the time and is an initial value. The first shutter blade **31** and the second shutter blade **32** are modularized respectively with the first driver **35** and the second driver **36**. When the first shutter blade **31** and the second shutter blade **32** are disposed crossover from each other (e.g., in a top-to-down overlap configuration), it is convenient to replace the module of the first or the second shutter blade **31**, **32** without interfering by another module.

Please refer to FIG. **5** with reference to FIG. **3**. When the first driver **35** drives the first shutter blade **31** and makes it be located at the turn-on position and the second driver **36** drives the second shutter blade **32** and makes it be located at the turn-off position, the first arc contour **310** of the first shutter blade **31** will park at a position corresponding to a part of contours of the openings **340**, **330**, and **220** respectively of the bottom plate **34**, the cover plate **33**, and the supporting base **22** and the second driver **36** makes the second hole O**2** of the second shutter blade **32** move toward the optical axis of the camera lens and shift to a position overlapping the aperture of the plate (e.g., the bottom plate **34**, the cover plate **33**, or the supporting base **22**). Meanwhile, the aperture of the camera device is defined by the second aperture of the second hole O**2** of the second shutter blade **32**.

Please refer to FIG. **6** with reference to FIG. **3**. When the first driver **35** drives the first shutter blade **31** and makes it be located at the turn-off position and the second driver **36** drives the second shutter blade **32** and makes it be located at the turn-on position, the second arc contour **320** of the second shutter blade **32** will park at a position corresponding to a part of contours of the openings **340**, **330**, and **220** respectively of the bottom plate **34**, the cover plate **33**, and the supporting base **22** and the first driver **35** makes the first hole O**1** of the first shutter blade **31** move toward the optical axis of the camera lens and shift to a position overlapping the aperture of the plate (e.g., the bottom plate **34**, the cover plate **33**, or the supporting base **22**). Meanwhile, the aperture of the camera device is defined by the first aperture of the first hole O**1** of the first shutter blade **31**.

The afore-described framework can carry out a three-stage aperture adjustment. The aperture of the optical system can be adjusted to the aperture of the plate, the first aperture, and the second aperture. In addition, the first driver **35** and the second driver **36** can be deployed at the lateral side of the optical system frame, for example, be disposed at two opposite sides of the driver supporting base. The above-described embodiments are illustrated by two shutter blades **31** and **32** cooperating with two drivers **35** and **36**. It can be understood that assuming that one shutter blade and one driver are taken as a set of aperture adjusting device, there can have only one set of aperture adjusting device. However, it can also deploy three, four, or more sets of aperture adjusting device at the lateral side of the optical system frame for carrying out a multi-stage aperture adjustment. Further, it can also deploy two or more than two blade rooms arranged front and back. The holes of the shutter blades in the blade rooms are arranged with different apertures. In this way, this increases the number of types of aperture for the user to choose.

The present invention further provides a fourth embodiment. As shown in FIG. **7**, the fourth embodiment follows the reference numbers used in the third embodiment. The difference between the fourth embodiment and the third embodiment is that the camera device of the fourth embodiment includes the first shutter aperture **31** and the first driver **35** without including the second shutter aperture **32** and the second driver **36**.

Please refer to FIG. **8** with reference to FIG. **7**. When the first driver **35** drives the first shutter blade **31** and makes it be located at the turn-on position, the first arc contour **310** of the first shutter blade **31** will park at a position corresponding to a part of contours of the openings **340**, **330**, and **220** respectively of the bottom plate **34**, the cover plate **33**, and the supporting base **22**. That is, the aperture of the overall camera device is unchanged at the time and is an initial value. The first shutter blade **31** is modularized with the first driver **35**.

Please refer to FIG. **9** with reference to FIG. **7**. When the first driver **35** drives the first shutter blade **31** and makes it be located at the turn-off position, the first driver **35** makes the first hole O1 of the first shutter blade **31** move toward the optical axis of the camera lens and shift to a position overlapping the aperture of the plate (e.g., the bottom plate **34**, the cover plate **33**, or the supporting base **22**). Meanwhile, the aperture of the camera device is defined by the first aperture of the first hole O1 of the first shutter blade **31**.

The basic structure of the optical lens of the present inventions are illustrated by FIG. **10**A, FIG. **11**A, FIG. **12**A, FIG. **13**A and FIG. **14**A (respectively corresponding to a fifth, a sixth, a seventh, an eighth and a ninth embodiments). The basic structure of the optical lens of the present inventions are described by Table 1, Table 2, Table 3, Table 4 and Table 5 (respectively corresponding to a fifth, a sixth, a seventh, an eighth and a ninth embodiments). The optical lens comprises a lens group, which establishes an optical axis OA and is arranged along the optical axis OA. Object light rays enter such an optical system from an object side OBJ of the optical axis OA and form an image on an image plane IP at an image side IMA thereof. The optical lens further comprises a first aperture stop STO**1** and a second aperture stop STO**2**. Preferably, the first aperture stop STO**1** is disposed inside the lens group, that is, between any two lenses of the lens group; and the second aperture stop STO**2** is disposed outside the lens group at the outside of the object side OBJ of the optical axis OA, that is, at the outside of a lens of the lens group at the most object side OBJ.

In the illustrated optical lens, the aperture of the optical lens is defined by the aperture of the second aperture stop STO**2** when a smaller aperture is required; the aperture of the optical lens is defined by the aperture of the first aperture stop STO**1** when a larger aperture is required. For instance, when a smaller aperture is required, decrease the aperture of the second aperture stop STO**2** to be at least less than the aperture of the first aperture stop STO**1**. Since the aperture of the first aperture stop STO**1** is greater than that of the second aperture stop STO**2**, the first aperture stop STO**1** ceases to be effective due to the evolution of light path and is thus in an inactive state. Meanwhile, the second aperture stop STO**2** is in an active state, and therefore the smaller aperture of the optical lens is now defined by the aperture of the second aperture stop STO**2**. When a larger aperture is required, increase the aperture of the second aperture stop STO**2** to be at least greater than the aperture of the first aperture stop STO**1**. Meanwhile, the second aperture stop STO**2** ceases to be effective due to the evolution of light path and is thus in an inactive state. The first aperture stop STO**1** is in an active state, and therefore the aperture of the optical lens is now defined by the first aperture stop STO**1**. The afore-described example is illustrated by taking the second aperture stop STO**2** as an aperture stop with adjustable aperture for example. However, the following examples can also achieve above effects, that is, the first aperture stop STO**1** is an aperture stop with adjustable aperture or both of the first aperture stop STO**1** and the second aperture stop STO**2** are adjustable in aperture. However, the second aperture stop STO**2** that is adjustable in aperture has an advantage. That is, the aperture stop with adjustable aperture can be deployed at the outside of the lens at the most object side. Since there has more room for accommodating an aperture adjusting device in this configuration, the size of the optical lens can be reduced.

The afore-described optical framework improves the effective aperture range. In comparison to the optical lens having an aperture stop with adjustable aperture disposed within the lens group in the conventional skills, the optical lens of the present invention can deploy the aperture stop with adjustable aperture (that is, the second aperture stop STO2) at the outside of the lens group, and therefore the structural components or electric control components required to be used to mount the aperture-adjustable stop can be moved to the outside of the lens group, thereby carrying out further thinning of the optical lens.

The following is described with a package structure of the optical lens of the present invention.

Please refer to FIG. **15**, which is a schematic diagram showing a package structure in accordance with a fifth embodiment of an optical lens of the present invention. The optical lens is packaged in an electronic device equipped with a photographing function and is disposed inside an external case **11** of the electronic device. The external case **11** has an opening **110** exposed therefrom, and light rays can thus enter the inner space of the optical lens through the opening **110**. The optical lens has an optical system frame **15**, a lens system **17**, and an image recorder **18**. The optical system frame **15** is made of plastic and is a fastening member of the optical system. The lens system **17** comprises one or more lenses mounted on the optical system frame **15**. The image recorder **18** can receive the light rays transmitted from the lens system **17** and thus form an image on the image plane. The optical lens also has a transparent plate **12**, a cover plate **13**, a base plate **16**, and one or more aperture adjusting blades **14**. The base plate **16** is fastened on the optical system frame **15** or formed by extending from the optical system frame **15**. The base plate **16** has an opening **160** disposed at a central part thereof. The cover plate **13** is spaced apart from the base plate **16** and is fastened to the base plate **16** or the optical system frame **15**. The cover plate **13** is a flat metal plate and is perforated to form an opening **130** at a central part thereof. The opening **130** of the cover plate **13** corresponds to the opening **160** of the base plate **16**. The aperture adjusting blade **14** is disposed in an accommodating space formed between the cover plate **13** and the base plate **16**. This optical lens is an aperture-adjustable optical lens. The aperture adjusting blade **14** is driven by a driver (not shown) of an aperture adjusting device (not shown). The aperture of the optical lens is altered by adjusting the position of the aperture adjusting blade **14**. The transparent plate **12** is disposed at the inner side of the external case **11** and is disposed next to the exposed opening **110** of the external case **11**. Also, the transparent plate **12** is attached to the optical system frame **15**. As can be seen from FIG. **15**, the lens system **17**, the base plate **16**, the aperture adjusting blade **14**, the cover plate **13**, and the transparent plate **12** are sequentially arranged in order from the image side to the object side, that is, from the image recorder **18** to the exposed opening **110** of the external case **11**.

As described above, the aperture adjusting blade **14** is disposed between the lens at the most object side and the exposed opening **110** of the external case **11**. Therefore, in comparison to that disposed between any two lenses, this deployment leads to have more room at the lateral side for accommodating its driver and leads not to affect the deployment of other components. Further, the transparent plate **12** is fastened or attached to the optical system frame **15**. Such a technical scheme can further prevent the dust from falling into the blade room accommodating the aperture adjusting blade **14**.

Please refer to FIG. **16**, which is a schematic diagram showing a package structure in accordance with a sixth embodiment of an optical lens of the present invention. In comparison to the package structure described in the fifth embodiment, the present embodiment locates the base plate **16** at the upper side and locates the cover plate **13** at the lower side. Screws **19** are utilized to fasten the cover plate **13** to the base plate **16** or the optical system frame **15**. The cover plate **13** and the base plate **16** are spaced a part from each other. The aperture adjusting blade **14** is accommodated between the cover plate **13** and the base plate **16**. As can be seen from FIG. **16**, the lens system **17**, the cover plate **13**, the aperture adjusting blade **14**, the base plate **16**, and the transparent plate **12** are sequentially arranged in order from the image side to the object side, that is, from the image recorder **18** to the exposed opening **110** of the external case **11**. In such a technical scheme, the cover plate **13** is moved to the lower side and thus the plastic material of the optical system frame **15** can be partially removed for deploying a space for disposing the screws **19**, and therefore the fastening position of the screw can be moved down. In comparison to the embodiment shown in FIG. **15**, this embodiment can reduce the thickness of the optical lens, and thus reduce the thickness of the device equipped with the optical lens.

The optical lens provided in the present invention will be further described with reference to the following five embodiments taking a mobile phone camera lens for example and the data adopted in the respective embodiments are listed for reference. The fifth embodiment is illustrated in FIGS. **10**A to **10**E; the sixth embodiment is illustrated in FIGS. **11**A to **11**E; the seventh embodiment is illustrated in FIGS. **12**A to **12**E; the eighth embodiment is illustrated in FIGS. **13**A to **13**E; and the ninth embodiment is illustrated in FIGS. **14**A to **14**E.

Some lenses in the optical lens of the present invention are aspheric lenses. The shape of an aspheric lens may be expressed by the following formula:

$$z(r)=\frac{C\cdot r^2}{1+\sqrt{1-(1+k)\cdot C^2\cdot r^2}}+\alpha_1 r^2+\alpha_2 r^4+\alpha_3 r^6+\alpha_4 r^8+\alpha_5 r^{10}+\alpha_6 r^{12}+\alpha_7 r^{14}+\alpha_8 r^{16}+\alpha_9 r^{18}+\alpha_{10} r^{20}\ldots$$

where z represents the sag of a point on the aspheric surface at a height h distanced to a central axis of the lens; C is a reciprocal of a paraxial curvature radius; r represents a height of a point on the aspheric surface with respect to the central axis; k is the conic constant of the aspheric lens; and $\alpha_1, \alpha_2, \ldots,$ and α_{10} are aspheric surface coefficients for even (greater than or equal to two) order terms.

FIG. **10**A is a schematic diagram showing an optical structure in accordance with a fifth embodiment of an optical lens of the present invention. The optical lens according to the fifth embodiment of the present invention comprises five pieces of lenses, which are a first lens L**1**, a second lens L**2**, a third lens L**3**, a fifth lens L**5**, and a fourth lens L**4** arranged in order from the image side IMA to the object side OBJ. The optical lens utilizes two low-dispersion lenses L**2** and L**3** cooperating with three high-dispersion lenses L**1**, L**4**, and L**5**. The framework of its refractive power is negative, positive, negative, positive, and positive in order form the image side to the object side. Specifically, the first lens L**1** is a lens having negative refractive power, and the image-side surface thereof is a concave face and has at least a point of inflection arranged thereon. The second lens L**2** is a lens having positive refractive power and has a concave surface facing the object side and a convex surface facing the image side. The third lens L**3** is approximate to a plano-concave lens. The fifth lens L**5** is approximate to a meniscus convex lens. The fourth lens L**4** is also approximate to a meniscus convex lens.

The optical lens according to the fifth embodiment of the present invention also has at least two aperture stops, that is, a first aperture stop STO**1** and a second aperture stop STO**2**. The first aperture stop STO**1** is disposed between the fourth lens L**4** and the fifth lens L**5** and the second aperture stop STO**2** is disposed at the outside of the lens at the most object side (that is, the fourth lens L**4**). The distance on the optical axis from the first aperture stop STO**1** to the image plane IP is SL**1**, the distance on the optical axis from the second aperture stop STO**2** to the image plane IP is SL**2**, and the distance on the optical axis from the object-side surface of the lens at the most object side (that is, the fourth lens L**4**) to the image plane IP is TTL. The optical lens according to the fifth embodiment of the present invention satisfies the following equation: 1.2<(SL**1**+SL**2**)/TTL<2.5.

As shown in Table 1 below, related data of the respective lenses of the optical lens shown in FIG. **10**A are shown in the condition that the first aperture stop STO**1** is in an active state and the second aperture stop STO**2** is in an inactive state. Table 1 shows that the focal length of the optical lens according to the fifth embodiment of the present invention is 4.363, and the refractive power for the respective lenses sequentially is −6.54966, 20.2192, −4.7998, 4.1284, and 4.7496 in order from L**1**, L**2**, L**3**, L**5**, and L**4**. In the condition that the first aperture stop STO**1** is in the active state, the effective f-number of this optical system is 1.8, the viewing angle is 76 degrees, and the total length of the optical lens is 5.21 mm. Further, in the condition that the second aperture stop STO**2** is in the active state, the effective f-number of this optical system is 2.4.

TABLE 1

Focal length = 4.36 mm F-number = 1.8 Maximum half angle of view = 38						
Surface Index		Radius of Curvature R (mm)	Thickness/ Distance D (mm)	Refractive Index (Nd)	Abbe No. (Vd)	Conic Constant
R0	Image Side					
R1	IR	Plano	0.399847	1.5168	64.16734	0
R2		Plano	0.145			0
R3	L1	∞	0.517358	1.535037	55.71072	−7.31959
R4		3.224664	0.687077			−37.468
R5	L2	−6.84747	0.316889	1.651	21.5	12.32
R6		−13.594	0.626108			−3121.95
R7	L3	−202.472	0.655789	1.651	21.5	−7063.6
R8		−3.109	0.232827			0
R9	L5	−2.63506	0.038179	1.79679	45.35	0
R10		−11.8121	0.530297			0
R11	STO1	∞	0.301989			0
R12	L4	4.492898	0.090208	1.58913	61.18217	0
R13		1.824606	0.67288			−0.68912
R14	STO2	∞	0			0
R15	Object Side					

Table 2 shows related data of aspheric lenses shown in Table 1.

TABLE 2

IMA	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.068326463	0.022631598	−0.005707664	0.00079391
of L1	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	−5.06E−05	−5.04E−08	1.18281E−07	1.18281E−07	1.18281E−07
OBJ	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.16234125	0.063601191	−0.014359732	−0.000663867
of L1	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	0.000669046	−5.70E−06	−1.02112E−05	−1.02112E−05	−1.02112E−05
IMA	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.037355326	0.056839178	−0.047227199	0.017140171
of L2	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	−0.002734669	−7.68765E−05	6.53917E−05	6.53917E−05	6.53917E−05
OBJ	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.046389552	0.054728295	−0.087083506	0.053893156
of L2	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	−0.016201546	0.000158368	0.000723711	0.000723711	0.000723711
IMA	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.064112847	0.017941495	0.038314249	−0.029126597
of L3	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	0.008533352	0.002185878	−0.000751704	−0.000751704	−0.000751704
OBJ	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.072558289	−0.015939819	0.077639598	−0.013915421
of L3	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	−0.02624593	0.00666058	−0.000299104	−0.000299104	−0.000299104
IMA	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.013943442	0.020475405	−0.057163629	0.023398376
of L4	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	0.012274819	−0.012467014	−0.000474625	−0.000474625	−0.000474625
OBJ	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	0.006641832	0.01166876	−0.001369296	−0.022192564
of L4	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	0.025460709	−0.011215628	0.000876751	0.000376751	0.000876751
IMA	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.013306555	−0.034459418	0.011549355	0.044164219
of L5	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	−0.047675783	0.004435779	0.004355224	0.004355224	0.004355224
OBJ	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.02213491	−0.023906357	0.000935276	0.011708534
of L5	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	−0.028121262	0.009003516	0.002926885	0.002926385	0.002926885

FIG. **10**B is a diagram showing the optical performance including field curvature and distortion of the optical lens according to the fifth embodiment of the present invention in the condition that the first aperture stop STO**1** is in the active state and the second aperture stop STO**2** is in the inactive state. FIG. **10**C is a diagram showing the optical performance including field curvature and distortion of the optical lens according to the fifth embodiment of the present invention in the condition that the first aperture stop STO**1** is in the inactive state and the second aperture stop STO**2** is in the active state. FIG. **10**D is a diagram showing polychromatic diffraction modulation transfer function (MTF) of the optical lens according to the fifth embodiment of the present invention in the condition that the first aperture stop STO**1** is in the active state and the second aperture stop STO**2** is in the inactive state. FIG. **10**E is a diagram showing polychromatic diffraction modulation transfer function of the optical lens according to the fifth embodiment of the present invention in the condition that the first aperture stop STO**1** is in the inactive state and the second aperture stop STO**2** is in the active state.

TABLE 3

Focal length = 3.29 mm F-number = 2.0 Maximum half angle of view = 34.5						
Surface Index		Radius of Curvature R (mm)	Thickness/ Distance D (mm)	Refractive Index (Nd)	Abbe No. (Vd)	Conic Constant
R0	Image Side					
R1	IR	Plano	0.004258	1.5168	64.16734	0
R2		Plano	0.145			0
R3	L1	∞	0.88	1.5441	56.0936	−6.35903
R4		4.088057	0.378762			−133.327
R5	L2	−1.05192	0.238975	1.5441	56.0936	−0.77093
R6		−2.37771	0.450713			0.179669
R7	L3	−6.89504	0.464627	1.5441	56.0936	28.14493
R8		10.49814	0.390025			20.16273
R9	L5	1.193641	0.364742	1.635517	23.97184	−6.08747
R10		2.664022	0.215475			−35.7261
R11	STO1	∞	0.036573			0
R12	L4	−6.82072	−0.00473	1.5441	56.0936	7.335077
R13		1.644252	0.408306			0.125673
R14	STO2	∞	0			0
R15	Object Side					

Table 4 shows related data of aspheric lenses shown in Table 3.

TABLE 4

IMA	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	−0.12261161	0.049977706	−0.017665442	0.003089853
of L1	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	−2.24E−04	0.00E+00	0	0	0
OBJ	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	−0.16359498	0.04211978	−0.001194497	−0.000624809
of L1	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	4.89916E−05	0.00E+00	0	0	0
IMA	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	0.24409123	−0.17355054	0.070243881	−0.004203009
of L2	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	−0.000699114	0	0	0	0
OBJ	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	0.038536069	−0.11142259	0.013661737	−0.021625202
of L2	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	−0.013949816	0	0	0	0
IMA	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	−0.055902836	−0.038874183	0.017980386	−0.028521372
of L3	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	0.042884788	0	0	0	0
OBJ	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	−0.051388901	−0.03247322	0.15238218	−0.077963205
of L3	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	−0.013538712	0	0	0	0
IMA	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	0.13622006	−0.16886925	0.34374751	−0.58600811
of L4	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	0.4616599	0	0	0	0
OBJ	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	0.009462623	−0.012480374	−0.01772093	0.044712063
of L4	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	0.013373029	0	0	0	0
IMA	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	0.044795139	0.11055632	−0.15080884	−0.070661935
of L5	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	0.095626162	0	0	0	0
OBJ	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	0.040196019	−0.090194898	0.2241962	−0.41489922
of L5	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	0.22564468	0	0	0	0

FIG. **12**A is a schematic diagram showing an optical structure in accordance with a seventh embodiment of an optical lens of the present invention. The optical lens according to the seventh embodiment of the present invention comprises four pieces of lenses, which are a first lens L**1**, a second lens L**2**, a third lens L**3**, and a fourth lens L**4** arranged in order from the image side IMA to the object side OBJ. The optical lens utilizes one low-dispersion lens L**3** cooperating with three high-dispersion lenses L**1**, L**2**, and L**4**. The framework of its refractive power is negative, positive, negative, and positive in order form the image side to the object side. Specifically, the first lens L**1** is a lens having negative refractive power, and the image-side surface thereof is a concave face and has at least a point of inflection arranged thereon. The second lens L**2** is a lens having positive refractive power and has a concave surface facing the object side and a convex surface facing the image side. The third lens L**3** is approximate to a meniscus concave lens. The fourth lens L**4** is approximate to a bi-convex lens.

The optical lens according to the seventh embodiment of the present invention also has at least two aperture stops, that is, a first aperture stop STO**1** and a second aperture stop STO**2**. The first aperture stop STO**1** is disposed between the third lens L**3** and the fourth lens L**4** and the second aperture stop STO**2** is disposed at the outside of the lens at the most object side (that is, the fourth lens L**4**). The distance on the optical axis from the first aperture stop STO**1** to the image plane IP is SL**1**, the distance on the optical axis from the second aperture stop STO**2** to the image plane IP is SL**2**, and the distance on the optical axis from the object-side surface of the lens at the most object side (that is, the fourth lens L**4**) to the image plane IP is TTL. The optical lens according to the seventh embodiment of the present invention satisfies the following equation: $1.2<(SL1+SL2)/TTL<2.5$.

As shown in Table 5 below, related data of the respective lenses of the optical lens shown in FIG. **12**A are shown in the condition that the first aperture stop STO**1** is in an active state and the second aperture stop STO**2** is in an inactive state. Table 5 shows that the focal length of the optical lens according to the seventh embodiment of the present invention is 2.224, and the refractive power for the respective lenses sequentially is −1.27834, 1.15622, −2.82002, and 1.81389 in order from L**1**, L**2**, L**3**, and L**4**. In the condition that the first aperture stop STO**1** is in the active state, the effective f-number of this optical system is 1.8, the viewing angle is 70 degrees, and the total length of the optical lens is 3.09 mm. Further, in the condition that the second aperture stop STO**2** is in the active state, the effective f-number of this optical system is 2.4.

TABLE 5

Focal length = 2.22 mm F-number = 1.8 Maximum half angle of view = 35

Surface Index		Radius of Curvature R (mm)	Thickness/ Distance D (mm)	Refractive Index (Nd)	Abbe No. (Vd)	Conic Constant
R0	Image Side					
R1	IR	Plano	0.377173	1.51633	64,14202	0
R2		Plano	0.3			0
R3	L1	0.634243	0.3	1.5441	56.0936	−7.33354
R4		8.27339	0.33814			−10914.700000
R5	L2	−0.65879	0.035445	1.69003	52.75	−3.17751
R6		−2.65838	0.459447			−8.45873
R7	L3	1.547733	0.397755	1.632755	23.29495	−5.06099
R8		11.75026	0.229978			0
R9	STOl	∞	0.075473			0
R10	L4	−3.3504	−0.04548	1.54	56.0936	0
R11		1.313104	0.623902			0.124189
R12	STO2	∞	0			0
R13	Object Side					

Table 6 shows related data of aspheric lenses shown in Table 5.

TABLE 6

IMA	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.28029487	0.22709754	−0.15016616	0.034805119
of L1	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	−0.001965392	0.003020866	−0.001881296	−0.001881296	−0.001881296
OBJ	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.28339184	0.21241489	−0.093783116	−0.033079793
of L1	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	0.017751576	−0.023275011	0.028276075	0.028276075	0.028276075
IMA	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	0.056170984	−0.75262164	1.8432287	−1.4175232
of L2	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	−0.81543338	1.2821335	0	0	0
OBJ	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	0.004277422	0.014660242	−0.024193322	0.18893841
of L2	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	−1.7521547	2.2681374	0	0	0
IMA	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	0.12014168	−0.039058636	−0.73253478	4.5037627
of L3	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	4.6527637	0	0	0	0

TABLE 6-continued

OBJ	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	−0.13331015	−1.0335069	5.1431284	4.7487291
of L3	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	−1.1243573	0	0	0	0
IMA	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	−0.015180883	−1.1936464	4.9505495	−5.7629299
of L4	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	0	0	0	0	0
OBJ	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	−0.047670449	−0.1274337	0.12082106	−0.45177542
of L4	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	0	0	0	0	0

FIG. **12**B is a diagram showing the optical performance including field curvature and distortion of the optical lens according to the seventh embodiment of the present invention in the condition that the first aperture stop STO**1** is in the active state and the second aperture stop STO**2** is in the inactive state. FIG. **12**C is a diagram showing the optical performance including field curvature and distortion of the optical lens according to the seventh embodiment of the present invention in the condition that the first aperture stop STO**1** is in the inactive state and the second aperture stop STO**2** is in the active state. FIG. **12**D is a diagram showing polychromatic diffraction modulation transfer function (MTF) of the optical lens according to the seventh embodiment of the present invention in the condition that the first aperture stop STO**1** is in the active state and the second aperture stop STO**2** is in the inactive state. FIG. **12**E is a diagram showing polychromatic diffraction modulation transfer function of the optical lens according to the seventh embodiment of the present invention in the condition that the first aperture stop STO**1** is in the inactive state and the second aperture stop STO**2** is in the active state.

TABLE 7

Focal length = 2.318 mm F-number = 1.8 Maximum half angle of view = 44.5						
Surface Index		Radius of Curvature R (mm)	Thickness/ Distance D (mm)	Refractive Index (Nd)	Abbe No. (Vd)	Conic Constant
R0	Image Side					
R1	IR	Plano	0.105362	1.51633	64,14202	0
R2		Plano	0.21			0
R3	L1	0.898954	0.6844	1.5441	56.0936	−2.90282
R4		1.195782	0.452062			−0.44492
R5	L2	−1.26429	0.202173	1.650958	21.51361	0.051651
R6		−0.76452	0.455948			−0.24406
R7	L3	−1.19373	0.081371	1.755	51.2	0.037002
R8		4.0376	0.499949			5.994392
R9	STOl	∞	0.35304			0
R10	L4	8.735552	0.003026	1.755	51.2	0
R11		1.905175	0.362252			2.440844
R12	STO2	∞	0			0
R13	Object Side					

Table 8 shows related data of aspheric lenses shown in Table 7.

TABLE 8

IMA	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	−0.23128355	0.14175378	−0.067994162	0.0213542
of L1	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	−0.004568351	0.000508655	−1.12562E−05	−1.12562E−05	−1.12562E−05
OBJ	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	−0.52650509	0.25194	−0.17353961	0.14660685
of L1	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	−0.10183205	0.039677909	−0.006161127	−0.006161127	−0.006161127
IMA	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	0.27010932	0.06650994	−0.32301541	0.77365395
of L2	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	−0.94713717	0.59387626	−0.14295684	−0.14295684	−0.14295684
OBJ	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	0.66898512	−0.61306349	1.4858343	−1.342644
of L2	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	2.9844358	−6.412385	4.6891119	4.6891119	4.6891119
IMA	Coefficient on r^2	Coefficient on r^4	Coefficient on r^6	Coefficient on r^8	Coefficient on r^10
surface	0	−0.14982592	0.078819059	−0.63534856	2.5712369
of L3	Coefficient on r^12	Coefficient on r^14	Coefficient on r^16	Coefficient on r^18	Coefficient on r^20
	−3.7370466	1.9102048	−0.30854624	−0.30854624	−0.30854624

TABLE 8-continued

OBJ	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.28823379	−0.22965413	0.14621395	−1.3892127
of L3	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	−0.77150298	17.474959	−20.688299	−20.688299	−20.688299
IMA	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.178712	0.39455994	−2.7937285	1.5267098
of L4	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	28.838141	−82.831787	66.34717	66.34717	66.34717
OBJ	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.087825582	−0.23623031	0.25832584	−0.042191405
of L4	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	4.1396749	10.902824	−9.0782311	−9.0782311	−9.0782311

TABLE 9

Focal length = 4.15 mm F-number = 1.6 Maximum half angle of view = 39.5						
Surface Index		Radius of Curvature R (mm)	Thickness/ Distance D (mm)	Refractive Index (Nd)	Abbe No (Vd)	Conic Constant
R0	Image Side					
R1	IR	Plano	0.11413	1.5168	64.16734	0
R2		Plano	0.145			0
R3	L1	∞	0.8	1.535037	55.71072	−5.44208
R4		3.015938	0.745032			−17.1337
R5	L2	−6.7872	0.313655	1.651	21.5	12.06767
R6		−16.0254	0.554647			−2555.19
R7	L3	−100.075	0.591153	1.651	21.5	−11896
R8		−3.08129	0.232166			0
R9	L5	−2.76701	0.038179	1.79679	45.35	0
R10		−15.7774	0.641223			0
R11	STOl	∞	0.345203			0
R12	L4	4.659665	0.078218	1.59	61.18	0
R13		1.870937	0.598805			−0.69405
R14	STO2	∞	0			0
R15	Object Side					

Table 10 shows related data of aspheric lenses shown in Table 9.

TABLE 10

IMA	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.071190542	0.024244691	−0.00591398	0.000790785
of L1	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	4.92E−05	3.19E−08	9.62427E−08	9.62427E−08	9.62427E−08
OBJ	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.16500606	0.062901685	−0.014461672	−0.000675361
of L1	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	0.000665084	−5.40E−06	−9.74299E−06	−9.74299E−06	−9.74299E−06
IMA	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.03644324	0.056433494	−0.048174107	0.01705914
of L2	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	−0.002686547	−6.06425E−05	6.32451E−05	6.32451E−05	6.32451E−05
OBJ	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.035879366	0.049041986	−0.087187532	0.05414856
of L2	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	−0.016025378	0.000179043	0.000657297	0.000657297	0.000657297
IMA	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.061833968	0.014413759	0.036786997	−0.029378927
of L3	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	0.008084592	0.001797025	0.000727565	−0.000727565	−0.000727565
OBJ	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.07261039	−0.018200106	0.075646828	−0.013022632
of L3	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	−0.024606296	0.007762861	−0.000321085	−0.000321085	−0.000321085
IMA	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.015873347	0.023847742	−0.053177251	0.022204617
of L4	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	0.007014824	−0.015851821	0.005477248	0.005477248	0.005477248

TABLE 10-continued

OBJ	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	0.006465554	0.01071186	−0.00123002	−0.022193926
of L4	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	0.025220379	−0.011482542	0.000917697	0.000917697	0.000917697
IMA	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.017238977	−0.037305922	0.010955635	0.046272346
of L5	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	−0.044312667	0.006289162	0.002419004	0.002419004	0.002419004
OBJ	Coefficient on r^ 2	Coefficient on r^ 4	Coefficient on r^ 6	Coefficient on r^ 8	Coefficient on r^ 10
surface	0	−0.019858833	−0.025689834	0.000320202	0.014439705
of L5	Coefficient on r^ 12	Coefficient on r^ 14	Coefficient on r^ 16	Coefficient on r^ 18	Coefficient on r^ 20
	−0.025103433	0.009597725	0.000453701	0.000453701	0.000453701

In the embodiments of the present invention, the shutter blade has a hole having an aperture. The aperture of a camera lens can be adjusted by driving the shutter blade using a driver and thus making the hole move toward the optical axis and shift to a position overlapping the original aperture. There can have multiple sets of the shutter blade and the driver so as to carry out a multi-stage aperture adjustment of the camera lens. An adjustment of depth of field can thus be carried out by a selection of aperture. In addition, in the embodiments of the present invention, one shutter blade is cooperated with one driver. It is convenient in replacement when these components are malfunctioned.

While the preferred embodiments of the present invention have been illustrated and described in detail, various modifications and alterations can be made by persons skilled in this art. The embodiment of the present invention is therefore described in an illustrative but not restrictive sense. It is intended that the present invention should not be limited to the particular forms as illustrated, and that all modifications and alterations which maintain the spirit and realm of the present invention are within the scope as defined in the appended claims.

What is claimed is:

1. A camera device, which is disposed in an electronic apparatus, comprising:
- an optical system frame;
- the electronic apparatus having an external shell with an opening exposed;
- a lens system deployed in the external shell of the electronic apparatus and mounted on the optical system frame;
- a bottom plate fastened to the optical system frame or formed by extending from the optical system frame;
- a cover plate fastened to the bottom plate and distanced away from the bottom plate;
- a fastening member having a base and an elongated part extending from the base, the base of the fastening member accommodated in the bottom plate, and the elongated part of the fastening member penetrating the bottom plate and fastened to the cover plate;
- at least one shutter blade disposed between the cover plate and the bottom plate, configured to adjust an aperture of the camera device; and
- a transparent plate forming an accommodating space for accommodating the optical system frame, the bottom plate, and the cover plate, the transparent plate being located in the external shell and a part of the transparent plate being located between the bottom plate and the opening of the external shell, or between the cover plate and the opening of the external shell.

2. The camera device according to claim **1**, wherein the part of the transparent plate, the cover plate, the at least one shutter blade, and the bottom plate are arranged in order from the opening of the external shell to the lens system.

3. The camera device according to claim **2**, wherein the cover plate has a first opening, the bottom plate has a second opening, and light rays are transmitted to the lens system sequentially via the opening of the external shell, the part of the transparent plate, the first opening, and the second opening or emitted out from the opening of the external shell in a reverse order.

4. The camera device according to claim **1**, wherein the part of the transparent plate, the bottom plate, the at least one shutter blade, and the cover plate are arranged in order from the opening of the external shell to the lens system.

5. The camera device according to claim **4**, wherein the cover plate has a first opening, the bottom plate has a second opening, and light rays are transmitted to the lens system sequentially via the opening of the external shell, the part of the transparent plate, the second opening, and the first opening or emitted out from the opening of the external shell in a reverse order.

6. The camera device according to claim **1**, wherein the bottom plate has a concave part, the base of the fastening member is accommodated in the concave part of the bottom plate.

7. The camera device according to claim **1**, wherein the optical system frame is made of a plastic material and the cover plate comprises a flat metal plate.

8. The camera device according to claim **1**, wherein the lens system comprises at least two lenses and an aperture stop.

9. The camera device according to claim **8**, wherein the aperture established by the at least one shutter blade is smaller than or equal to the aperture of the aperture stop of the lens system.

10. A camera device, which is disposed in an electronic apparatus, comprising:
- an optical system frame;
- the electronic apparatus having an external shell with an opening exposed;
- a lens system deployed in the external shell of the electronic apparatus and mounted on the optical system frame;
- a bottom plate having a first opening, the bottom plate being fastened to the optical system frame or formed by extending from the optical system frame, the bottom plate further having a concave part formed thereon;
- a cover plate having a second opening, the cover plate being distanced away from the bottom plate;
- a fastening member having a base and an elongated part extending from the base, the base of the fastening member being accommodated in the concave part of the bottom plate, and the elongated part of the fastening

member penetrating the concave part of the bottom plate and being fastened to the cover plate; and

at least one shutter blade disposed between the cover plate and the bottom plate, configured to adjust an aperture of the camera device,

wherein light rays are transmitted to the lens system sequentially via the opening of the external shell, the first opening of the bottom plate, and an aperture established by the shutter blade, and the second opening of the cover plate, or emitted out from the opening of the external shell in a reverse order.

11. A camera device with adjustable aperture, comprising:

an optical system frame;

a lens system mounted on the optical system frame;

a plate configured to be fastened to the optical system frame or be formed by extending the optical system frame, the plate having an aperture;

a shutter blade coupled to the plate, the aperture of the plate being completely pervious to light when the shutter blade is at a first position, the aperture of the plate being partially pervious to light when the shutter blade is at a second position; and

a driver connecting to the shutter blade for causing a displacement of the shutter blade,

wherein the optical system frame comprises:

a supporting base;

a driver supporting base; and

a lens supporting base,

wherein at least two of or all of the supporting base, the driver supporting base, and the lens supporting base are integratedly formed.

12. The camera device according to claim **11**, wherein the shutter blade has a hole disposed thereon, a diameter of the hole of the shutter blade is less than that of the aperture of the plate.

13. The camera device according to claim **12**, wherein the driver makes the hole of the shutter blade move to a position overlapping the aperture of the plate.

14. The camera device according to claim **12**, further comprising an additional shutter blade coupled to the plate.

15. The camera device according to claim **14**, wherein the shutter blade and the additional shutter blade are disposed crossover from each other.

16. The camera device according to claim **15**, further comprising an additional driver connecting to the additional shutter blade, the additional driver causing a displacement of the additional shutter blade.

17. The camera device according to claim **16**, wherein the additional shutter blade has an additional hole disposed thereon, and wherein the additional driver makes the additional hole of the additional shutter blade move to a position overlapping the aperture of the plate.

18. The camera device according to claim **11**, further comprising a cover plate configured to be distanced away from the plate, the shutter blade being disposed between the cover plate and the plate.

19. The camera device according to claim **11**, wherein the shutter blade is pivotably connected to the plate.

20. The camera device according to claim **11**, wherein the driver is configured to drive the shutter blade to a turn-on position or a turn-off position; wherein when the driver drives the shutter blade to the turn-off position, the aperture of the camera device is defined by the size of the hole of the shutter blade.

21. The camera device according to claim **20**, wherein the shutter blade comprises an arc contour, and wherein when the driver drives the shutter blade to the turn-on position, the arc contour of the shutter blade corresponds to a part of contour of the aperture of the plate.

22. The camera device according to claim **11**, wherein the shutter blade is pivotably disposed on the optical system frame, the driver has a rotating rod which is driven by the driver and thus moves in an arc orbit, the shutter blade has an applying hole disposed thereon, the rotating rod penetrates the applying hole, the rotating rod applies force to the applying hole when rotates under control of the driver, thereby bringing out the shutter blade to move toward the turn-on position or the turn-off position.

23. The camera device according to claim **17**, wherein the additional shutter blade is pivotably disposed on the optical system frame, the additional driver has a rotating rod which is driven by the additional driver and thus moves in an arc orbit, the optical system frame has an orbital hole corresponding to the arc orbit, the additional shutter blade has an applying hole disposed thereon, the rotating rod penetrates the orbital hole and the applying hole, the rotating rod applies force to the applying hole when rotates under control of the additional driver, thereby bringing out the additional shutter blade to move toward the turn-on position or the turn-off position.

24. The camera device according to claim **11**, wherein the supporting base is configured to mount the plate and the shutter blade thereon; the driver supporting base is configured to mount the driver; and the lens supporting base is configured to mount a lens in the lens system thereon.

25. The camera device according to claim **24**, wherein the driver supporting base is disposed between the supporting base and the lens supporting base, and the driver is disposed at a lateral side of the driver supporting base.

26. The camera device according to claim **11**, wherein the lens system comprises:

a lens group establishing an optical axis, the lens group comprising a first negative lens, a second positive lens, a third lens, a fifth lens and a fourth positive lens arranged in order from an image side to an object side, wherein the first negative lens has an image-side surface which is a concave face and has a point of inflection arranged thereon; the second positive lens comprises a concave surface facing the object side and a convex surface facing the image side; the third lens is a plano-concave lens; the fourth lens is a meniscus convex lens; the fifth lens is a meniscus convex lens and disposed between the third lens and the fourth lens;

a first aperture stop disposed between the image side and the lens of the lens group at the most object side; and

a second aperture disposed between the object side and a lens of the lens group at the most object side;

the camera device further comprising:

a cover plate spaced apart from the plate and fastened to the plate;

a transparent plate attached to the optical system frame; and

wherein the lens group, the plate, the shutter blade, the cover plate, and the transparent plate are arranged in order from the image side to the object side,

wherein the shutter blade is included in the second aperture, the second aperture is altered by adjusting the shutter blade, the shutter blade is disposed between the plate and the cover plate,

wherein the lens group satisfies the following equation:

$$1.2<(SL1+SL2)/TTL<2.5,$$

where SL**1** is a distance on the optical axis from the first aperture stop to the image plane; SL**2** is a distance on the optical axis from the second aperture stop to the image plane; and TTL is a distance on the optical axis from an object-side surface of a lens of the lens group at the most object side to the image plane.

27. The camera device according to claim **11**, wherein the lens system comprises:

a lens group establishing an optical axis, the lens group comprising a first negative lens, a second positive lens, a third lens, a fifth lens and a fourth positive lens arranged in order from an image side to an object side, wherein the first negative lens has an image-side surface which is a concave face and has a point of inflection arranged thereon; the second positive lens comprises a concave surface facing the object side and a convex surface facing the image side; the third lens is a plano-concave lens; the fourth lens is a meniscus convex lens; the fifth lens is a meniscus convex lens and disposed between the third lens and the fourth lens; and

a first aperture stop and a second aperture stop separately located on the optical axis;

the camera device further comprising:

a cover plate spaced apart from the plate and fastened to the plate; and

a transparent plate attached to the optical system frame;

wherein the lens group, the plate, the shutter blade, the cover plate, and the transparent plate are arranged in order from the image side to the object side;

wherein the shutter blade is included in the second aperture, the second aperture is altered by adjusting the shutter blade, the shutter blade is disposed between the plate and the cover plate.

28. The camera device according to claim **11**, wherein the lens s stem comprises:

a lens group establishing an optical axis, the lens group comprising a first lens, a second lens, a third lens, and a fourth positive lens arranged in order from an image side to an object side;

a first aperture stop disposed within the lens group; and

a second aperture disposed at the object side outside the lens group; wherein

the lens group further comprises a fifth lens disposed between the third lens and the fourth lens, and the refractive power of the lenses of the lens group sequentially are negative, positive, negative, positive, and positive, or negative, positive, positive, negative, and positive in order from the image side to the object side, and wherein the first aperture stop is disposed between the third lens and fourth lens or between the fourth lens and the fifth lens,

wherein the second aperture is an adjustable aperture, and the aperture of the first aperture stop is greater than that of the second aperture when the second aperture is adjusted to be in an active state;

the camera device further comprising:

a cover plate having an opening, the cover plate being spaced apart from the base plate and fastened to the base plate through a screw,

wherein the lens group, the cover plate, the shutter blade, and the plate are arranged in order from the image side to the object side,

wherein the shutter blade is included in the second aperture, the second aperture is altered by adjusting the shutter blade, the shutter blade is disposed between the plate and the cover plate.

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